

chem
Read One-Step Photography

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1947**

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**Fiftieth
Year**

★ A SCIENCE SERVICE PUBLICATION ★

Action and Reaction

➤ **EQUAL AND OPPOSITE**, the forces of war and peace alternate in unhappy equilibrium in our present way of life. Many people, it seems, can work efficiently only to save their lives. Now that immediate danger is past, production has slackened instead of quickening to produce goods for the uses of peace rather than for the waste of war. Listening to the current claque it would seem that there are those who wish to bring back the horrors of recent years, to stabilize the frenzied rush of war-impelled manufacture.

Now, as never before, it is necessary for the world to choose decisively to follow the path of constructive peace. This does not mean the coward's role of appeasement. Neither does it mean the bluffer's way of "all for me and none for you." It means honest approach to the common human problems of the world, and scientific study of what everybody, working together, can do about them.

The world's resources are at a low ebb. Is it sensible to squander them still more irresponsibly so that this or that group can claim to own them for a mere generation or two? Wouldn't it be more sensible, in the face of certain famine of both food and fuel, to get the scientists of the world together to work on ways to minimize coming hardships? Scientists are the one group who already speak the same language all over the world—phrased in formulas that the layman fears only because he would rather quarrel than learn.

If he will not learn—our path to extinction already lies before us. And that means you! And it isn't funny!

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Old Chemicals in New Role

New Photographic Process Produces One-Step Print

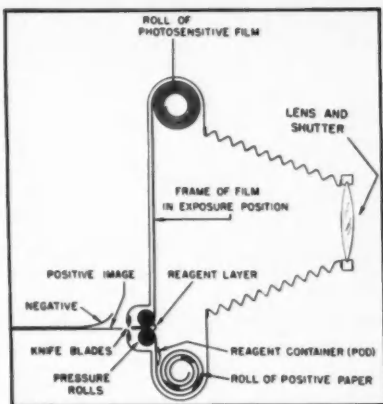
► A FINISHED photograph can be rolled out of the camera ready to be admired or used. A new process, developed by the inventor of polaroid, allows the production of a positive print, as well as a negative, within a minute after the shutter is clicked.

The chemicals are old, but they are used in a new way.

The camera, which can be made in the shape or size of most modern cameras, gives a finished, dry picture and completely developed negative in one minute without tanks and dark-rooms, or several days or weeks of waiting to get your films back from the corner drugstore. If the picture turns out badly, you can "shoot" it again on the spot.

A tiny pod or sealed chamber between the film and photographic paper loaded in the camera does the work of the tank and trays of chemicals in a photographer's darkroom. After a picture is snapped, a knob is turned to send the sandwich of film and paper through a wringer of two small rollers on the camera.

This pressure releases a few drops of viscous chemical and spreads a moist layer between the film and



paper. After one minute, you can strip away the film from the completed picture.

Chemical ingredients of the small pod include standard photographic developer, hydroquinone; fixer, sodium thiosulfate or hypo; and a viscous reagent. Each tiny container of chemicals contains enough to develop the negative and print the picture in a single-step operation in one minute.

The new process was demonstrated to the Optical Society of America meeting by its inventor, Edwin H. Land, president and director of research of the Polaroid Corporation, Cambridge, Mass. The new cameras are not yet on the market.

In addition to letting the amateur photographer see his snapshots one minute after he has taken a picture, the one-step camera will make it possible to put technical pictures to immediate use without using a dark-room.

The process, which will turn out pictures in temperatures ranging from

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the heat of midsummer to below freezing, can be adapted to color pictures and motion pictures.

In some of several one-step processes described, the negative can be used to print other pictures, and in all of them copies can be made by photographing the print or re-photographing the scene.

Mr. Land has developed four different methods of producing a finished picture in a single operation. In his soluble silver complex process, the developer and hypo perform twin duty between the film and the paper to utilize silver from the film in printing the picture.

Process in Brief

The process that is most practical and most likely to be used, given in more detail in the technical description of process C reproduced as a part of this article, is summarized as follows:

When light enters through the lens of a camera and falls on the film, it delivers some of its energy to the silver-bromide crystals with which the film is coated. If a crystal receives enough energy, a few atoms of pure metallic silver separate from it. With these specks already formed, the whole crystal is primed to turn quickly and completely into black metallic silver when it is later treated by the developing solution.

All modern films depend on this formation of a "latent image" by the light that enters the camera. In it, bright objects in the scene are represented by film areas in which many crystals are primed or "exposed" and ready for quick conversion into pure silver. Dark objects are represented by

areas in which most of the crystals are not exposed and will resist development.

In the usual photographic process, only the exposed crystals in the latent image are used. A developing agent, usually hydroquinone, turns them into the silver that forms the visible image. Then hypo (sodium thiosulfate), a good solvent for silver bromide, dissolves the unexposed and undeveloped crystals and washes them away. Because the exposed crystals form a negative image, darkest where the scene is lightest, the whole process has to be repeated to get a useful positive print.

The Land soluble silver complex process, employing standard photographic films, makes the positive print out of the silver that is ordinarily discarded.

The few drops of viscous chemical released within the paper-and-film sandwich when the knob sets the rollers in operation, contains both developer and hypo. Both chemicals go to work promptly, the hydroquinone turning the exposed crystals into silver on the film, the hypo taking into solution the silver of the unexposed crystals. The exposed crystals of the negative image are turned into silver, and kept within the film, out of circulation. The silver from the unexposed crystals, however, is free to move. The hypo takes it into solution within the thin layer of reagent between paper and film. There, the hydroquinone and other chemicals develop it and deposit it to form the positive image.

In effect, the developer performs the double service of holding silver of the exposed grains out of circulation

in the negative, and forming the positive image from the silver carried into solution by the hypo. The hypo performs a shuttle service, carrying the silver in the unexposed crystals from the film to the paper, and returning for more when its load of silver complex has been taken from it by the other chemicals.

In addition to the plastic, the developer and the hypo, a number of other ingredients are used in the viscous mixture contained in the pod, or on the surface of the receiving paper, to control the size of the silver particle which determines the color of the print; to control the rates at which the various reactions occur; to prevent discoloration of the print; and to make the process work over a wide temperature range.



► PULLED from the camera one minute after exposure, this portrait of Edwin H. Land, the inventor, is a demonstration of the quality of image produced by the new one-step photographic process.

Classification of Processes

Excerpt from the Journal of the Optical Society of America, February 1947.

► SO MANY requirements are to be made of the thin layer of reagent that it seems desirable to consider these requirements systematically.

The general question that will now be examined is: In what ways might a reagent act to form a negative and a positive at the same time?

Class A—Exhausted Developer Processes. Assume that the reagent that is spread over the exposed silver halide emulsion layer in the negative has the characteristics of an ordinary developer, except that it is *concentrated* enough to have within its very

small volume the molecules needed to complete the development of the negative and *alkaline* enough to effect prompt development. Shortly after the reagent is spread, the negative image will have developed, and in so doing, it will have formed in the reagent layer an image in terms of oxidized developing agent. The exposed silver halide grains will, as they develop, oxidize the reagent responsible for their development, and this oxidized reagent will at least for a short time remain in the neighborhood of the exposed grains. If the positive layer

is an ordinary photographic emulsion that has been pre-exposed *uniformly*, then it, too, will develop; but the amount of development at any point will be limited by the amount of *un-oxidized* developing agent available at that point. There will thus be formed on this ordinary photographic paper a positive image. This image will be unsatisfactory for our purposes in at least two of three ways: (1) it will not be fixed; (2) either the highlights will not be white, because development is allowed to start in them immediately upon the spreading of the reagent and before the development of the negative has proceeded far enough to exhaust the developing agent appreciably; or (3) the definition of the positive image will be impaired because development of the positive is delayed (to preserve contrast) so that lateral diffusion of the developing agent occurs during the time of the development of the negative.

Thus, this simplest of approaches involving the simultaneous development of negative and positive would at first appear not to be suitable. (Actually, in the primary process to be discussed in Class C, the phenomenon of developer exhaustion is made use of, not so much for formation of the image, as for assistance in stabilization of the image.) Some devices can be employed to improve developer exhaustion technics. (1) A barrier layer of plastic, coated over the positive sheet, can be used to delay development of the positive until development of the negative is complete. (2) The developing agent, in an inert state, may be incorporated in the emulsion layer, so that development

of the positive is not initiated until exhaustion of the developer is accomplished.

Class B—Oxidized Developer Processes. These processes, which have been explored with some success, call for forming from the oxidized developing agent either a bleach for a black dye, or a white pigment to be precipitated on a black surface. In spite of lack of experience with the questions of photographic quality involved in forming a white image on a black background, this class of processes was examined seriously because of the simple quantitative relationship that can exist between the number of grains developed, the number of molecules of oxidized developing agent formed, and the number of molecules of white pigment resulting. The pigment is produced by the reaction of the oxidized developing agent with additional reagent located either in the viscous layer or in one of the outer sheets of the sandwich. Symbolically, the loss of contrast does not occur in Class B because the positive cannot start forming until a reaction has occurred in the negative. Loss of definition can be minimized because it is possible to utilize the reactions of development as fast as they occur to provide the material for the positive image. This class thus satisfies a necessary condition for high resolving power.

Class C—Soluble Silver Complex Processes. It is with the process now to be described that most of the remainder of this paper (after Class D) will be concerned. It is characterized by the simultaneous development of positive and negative images in adjacent layers, the positive image being

formed from the silver halide of the unexposed grains of the negative. In the ordinary reversal process used for amateur motion picture film described above, it will be recalled that the positive is made by first developing the exposed grains, removing the silver, then fogging and developing the remaining grains. That is, stated generally, the positive is made from the unexposed grains in the negative. In this general sense, the processes of Class C bear a resemblance to the ordinary reversal process. In the Class C processes, the reagent dissolves the unexposed grains while it is developing the exposed grains and precipitates the solution of unexposed grains as a metallic silver positive in a layer adjacent to the negative. The reagent is spread between the negative and positive sheets, diffuses into the negative layer, develops it, and at the same time removes from it the unexposed grains which it then reduces to metallic silver, either in the thin layer of reagent or on the surface of the positive sheet, so that when the negative is stripped away the positive image remains. The positive image thus formed is similar to that of an ordinary print in that the highlights are the regions where no silver is precipitated and the shadows are the regions where varying amounts of silver have been precipitated.

These processes were developed in response to the fourfold question: Is it possible to form a reagent which will (1) develop to silver those grains in the emulsion that would be developed in an ordinary tray or tank developer, and (2) at the same time dissolve the other grains and yet (3) allow this solution of unexposed

grains to diffuse out of the negative layer, and also (4) cause the metal ion in the solution to precipitate as the positive image in the layer adjacent to the photosensitive emulsion? In view of the problems previously discussed, some additional questions must be asked about a reagent for Class C: Can this reagent be so made that no image can form in the positive until the negative image has begun to be developed? Can the image in dissolved halide be utilized as fast as it is formed so that time for lateral diffusion is minimized? Can the whole process of simultaneous formation of negative and positive proceed rapidly enough to complete the picture within a minute? Finally, can the relative rates of dissolving, diffusing, and precipitating on the one hand, and developing on the other hand, be kept sufficiently invariant with temperature so that pictures of substantially the same quality will be formed over a wide range of temperatures?

There is some limited experimental support for the feasibility of a reagent which will combine the functions of developing the exposed grains and dissolving the unexposed grains.¹ In these experiments, it was found possible to make up preparations of developers containing hypo which would, for certain emulsions and at certain temperatures, develop and fix a negative in one bath over a period of about twenty minutes.² For one-step processes, the problems to be

¹Richmond, W. D., *Concurrent Development and Fixation*, Brit. J. Photography, 36, 827-8 (1889).

²Lumiere, A. and L., and Seyewetz, A. *Combined Development and Fixation*, Brit. J. Photography, 72, 44-45 (1925).

solved are far more difficult. It is required not only that the process work satisfactorily over a relatively wide temperature range, but also that the processing time be reduced to a minute, and that a usefully sharp and dense image be formed from the solution of unexposed grains.

Now, if there existed a solvent that discriminated directly and effectively between unexposed and exposed grains in favor of the former, the transport of the silver ions would be greatly simplified. All that would be required would be to subject the negative to the solvent action, and to precipitate the silver in a layer outside the negative. However, this kind of solvent would be a radically new kind of developer since, for it, the latent image would be a catalyst inhibiting solution. Development would mean that the reagent would ignore the exposed grains and dissolve the unexposed. Ordinary hypo and other silver halide solvents do discriminate very slightly between exposed and unexposed grains in a silver halide emulsion, the unexposed grains having a slightly greater solubility than the exposed. The discriminating effect, however, is so trivial that it cannot be utilized practically.

It is apparent, then, that since there is no satisfactory reagent for dissolving unexposed grains without dissolving exposed grains, an image-forming technique that is to utilize *unexposed* grains in solution must depend on removing exposed grains from the realm of solubility. This suggests that as the proposed reagent diffuses into the negative layer, the exposed grains must be developed into silver at least as rapidly as the unexposed grains go

into solution. This dependency implies that the silver grains are essentially insoluble in the reagent that is chosen as solvent for the unexposed silver halide grains. It also implies that the unexposed grains are adequately insensitive to the reducing action of the reagent. One can thus visualize, as the reagent permeates stratum after stratum of the negative layer, an advancing reaction front in which exposed grains are not dissolving but are developing to silver and unexposed grains are not developing but are dissolving.

These are stringent demands indeed, because the requirement that the process be complete in one minute means that the developing potential of the reagent must be high. Furthermore, the requirement that the total quantity of reagent for development of negative and positive be contained in the very thin viscous layer, that is spread between the two sheets, means that the concentration of reducing agent must be extremely high. Thus the solution of silver ions must exist unreduced in the negative in a vigorous reducing environment. Similarly, the exposed but undeveloped grains must not dissolve in a vigorous dissolving environment.

There is a happy combination of requirements, however, in the need (1) for having the reaction proceed rapidly, and (2) for utilizing the image in dissolved grains as rapidly as it forms. It is desirable to complete the process rapidly, not only for convenience but also because it would be extremely difficult to maintain the dissolved ions unreduced in the negative layer for a long time. Thus rapid processing makes more silver available to

the positive and, incidentally, helps to limit the time of diffusion.

The processes of Class C, then, call for symmetrically advancing fronts of reaction in negative and positive, the front in the negative comprising developing and dissolving, the front in the positive comprising developing the dissolved silver ions.

One way of looking at Class C is that it provides a mechanism for developing both the exposed and the unexposed grains at the same time but in different strata.

Class D—Coupler Processes. Modern three-color photography depends on reacting the oxidized developer in place with couplers to give dyes. In some of these processes, a soluble coupler is used in the reagent, and in others the coupler is incorporated in the emulsion, either in insoluble form or associated with some insoluble organic material. Couplers can be used in one-step processes in ways analogous to Classes A, B, and C above.

Coupler Analogue of Class A. If the coupler is included with the reagent so that a dye forms where the silver particles develop, the residual unoxidized developer with the coupler dissolved in it can be made to couple by an oxidizing agent at the surface of the positive sheet. This process has the same limitations as Class A (developer exhaustion) and can be similarly improved by the use of a barrier layer of plastic over the oxidizing agent, although again at a sacrifice of definition.

Coupler Analogue of Class B. In the ordinary photographic color processes, the oxidized developer becomes one of the participants in the coupler reac-

tion to form the color. These color processes yield a negative and hence are usually used in the second development stage of a reversal process. In Class B processes, the positive is obtained directly rather than after reversal by causing the coupler product to be a highlight material rather than a shadow material. A dye cannot be used but a bleach or pigment can be used in this way.

Coupler Analogue of Class C. The coupler analogue to Class C requires an equilibrium for the solubility of the coupler similar to the equilibrium that has been achieved in Class C for the relative solubility of exposed and unexposed grains. A coupler is present in the negative layer and its molecules have moderate mobility. As the developing agent diffuses into the negative layer, the exposed grains oxidize the developer in their neighborhood, and the oxidized developer couples with the coupler to give a dye of lower mobility. In the region of the unexposed grains, the coupler dissolves in the developer and diffuses out of the negative into the adjacent layer. If in the positive layer there is present an oxidizing agent of low mobility, then when the coupler diffusing from the unexposed portion of the negative reaches the oxidizing region, it will couple with the oxidized developer in that region. This will produce a positive image, and the color of the image will depend on the combination of developing agent and coupler that is chosen. These combinations have, of course, been thoroughly studied in color photography techniques and need not be given here. Not so much has been done to find products that will couple to give

a black directly, but mixtures of couplers or developers can be used. The requirements with relation to solubility are similar to those for the silver ions in Class C. Development should just precede the dissolving reaction, and the reaction in the positive layer with the transferred solution should be rapid and should utilize the solution from each stratum as fast as the development of the negative in that stratum occurs.

The Problem of Stabilization. Obviously, one of the characteristics of any process which we select must be that it yields a print which requires no washing. Since any incompleting reactions are likely to go to completion, and since reagents subject to aerial oxidation are likely to oxidize with time, particularly if the oxidation is accelerated by radiation, an unwashed print in general can be expected to become stained. Furthermore the density of the image-forming material may be destroyed by bleaching reactions if the development residues are left at random in the print.

The stabilization of the one-step

positive print must thus be made an integral part of the process. In general, as much of the reagent as possible, insofar as it is not part of the image itself, should be left in the negative layer, which is stripped away. The reagents that must remain in association with the image should be left in an environment in which they do not discolor. Precautions must be taken to keep out of the final image reagents that might react to bleach the image-forming material. Particularly important among the techniques that have been used to obtain satisfactory stabilization is the use in the positive layer of components that diffuse into the reagent during the latter part of the period of image formation, to decrease the reduction potential by automatic neutralization or acidification of the reagent layer after the image is formed. Other techniques involve the use of antioxidants, the concentration of the excess reagent and its oxidation products in a layer other than that of the positive image, and the use of developing agents that do not form colored oxidation products.

Eyeglass Lenses Molded

► SMALL optical lenses of eyeglass size can now be produced in quantity, as finished articles, without grinding and polishing, by a molding process which is carried out in an atmosphere of hydrogen.

The products of the new method, while satisfactory for many uses, do not have the optical quality of high precision polished lenses. An improved press, however, is expected to yield a product accurate enough for some telescope systems. The present lenses pro-

duced by this method are less than two inches in diameter.

The process was developed by scientists of the Eastman Kodak Company, and a report has been prepared by them which has just become available from the Office of Technical Services, U. S. Department of Commerce.

Before this method was discovered it had not been possible to mold suitable lenses which were free from defect due to the uneven chilling of the hot slug of glass on contact with the mold.

Streptomycin Saving Victims Of Some Forms of White Plague

Chemical Attack on Tuberculosis

First chemical conqueror of tuberculosis has come from a microbe living in the earth. The story of this "magic bullet" which checks the progress of tuberculosis germs in the human body and has already saved victims of the white plague is told by Science Service's medical writer.

by JANE STAFFORD

► THERE ARE a few dozen men and women alive today whose survival means more than the saving of that number of human lives.

They are the "human guinea pigs" who point the way to a chemical conquest of the great white plague, tuberculosis.

Streptomycin, obtained from a mold-like microbe living in the soil, already recognized as a great fighter of tularemia or rabbit fever, has saved their lives. It seems to be also the long-sought chemical weapon against tuberculosis.

Even the doctors, who have seen so many promising weapons against TB fail, are now frankly excited. For the first time in history they have a drug that checks the progress of the white plague in human beings. "The first real lead toward conquest of tuberculosis" is their conservative, restrained way of putting it.

The drug that is causing excitement in medical circles as well as among the general public comes from a microbe that is between mold and bacteria.

It is a kind of sister to that other "miracle" drug from a mold, penicillin.

Unlike penicillin, streptomycin was not discovered by a lucky accident. No favorable breeze wafted it into an alert scientist's laboratory. Instead, it was found after five years of laborious searching and digging by Dr. Selman A. Waksman and associates at Rutgers University and the New Jersey Agricultural Experiment Station.

You can buy streptomycin at your drug store today if you have a doctor's prescription for it. Three years ago, and until very recently, it was available only in small amounts. It cost so much that few could have bought it even if it had been for sale. Now enough to treat a TB patient, who must get large doses of it, can be bought for from \$5 to \$10 per day. Treating tuberculosis with streptomycin is still not cheap, since the patient gets it every day for from four to eight weeks.

Veterans Saved by Drug

Veterans with tuberculosis are among the small group whose lives have been saved by this new drug. Among 200 or so patients at seven VA hospitals throughout the country who got streptomycin were 50 with a particularly severe form of the disease.

It is called miliary—not military but miliary—tuberculosis. The name comes from the Latin word miliaris,

meaning like a millet seed. Spread by the blood stream throughout the body the TB germs scatter millet seed-like sores. Every organ may be affected. In some cases the germs attack the membranes covering the brain. This is tuberculosis meningitis.

Of the 50 veterans with this severe miliary tuberculosis, 27 are now alive, thanks to streptomycin. By all ordinary standards they should be dead, said Dr. Paul A. Bunn, of VA's tuberculosis division, reporting for all VA doctors using the new drug. The 27 are not entirely "healthy specimens," but still, they are alive, with a chance to fight on through to health.

Before streptomycin was given to patients in VA hospitals, it went through a trial by fire, first in the bodies of guinea pigs with tuberculosis and then in the bodies of a few desperately sick TB patients in mental hospitals. Working in secrecy, lest news of the trials arouse false hopes in patients, Drs. H. Corwin Hinshaw and William H. Feldman at the Mayo Clinic and Foundation started the streptomycin push against TB.

Now they dare to talk about it openly and with enthusiasm. The results they got, good in some cases and disappointing in others, have been duplicated by other doctors treating patients in other parts of the country. This means streptomycin is no flash-in-the-pan. Its value and its limitations for TB-fighting have now been confirmed. Other doctors, your doctor perhaps, will rightly feel encouraged to try it now.

Besides the VA doctors reporting through Dr. Bunn, Drs. Walsh McDermott and Carl Muschenheim, of Cornell Medical College and New

York Hospital, have reported. They have treated almost 50 TB patients with streptomycin during the past year.

Germs Develop Resistance

Patients with lung tuberculosis, the most common kind of TB, often begin to get well quickly. Fever goes down within the first few weeks. The sometimes racking cough that produces dangerous, germ-laden material stops. The patient's appetite comes back, he feels much better and begins to regain weight. X-ray pictures show how the cavities or spots on the lungs are healing. These are among the good results. The disappointments come when the drug stops checking the germs because they have grown resistant to it. Then the patient who was on the way to getting well relapses and sometimes dies. This is the biggest problem doctors still have to lick. They have also to learn how much streptomycin is the right dose in each case, and how to prevent the dizziness, deafness and skin rashes that sometimes come from the drug.

Tuberculosis is not just one disease but many. It can attack bones, joints, the eyes, and any organ of the body. Whether streptomycin will do good in all these kinds of tuberculosis is not known yet.

The drug stops the germs on their rampage through the body, gives a chance for cavities and ulcers to heal and for the surgeon in some cases to help speed the healing. To the doctors, streptomycin is not a "cure" for TB, but a germ-stopper, or suppressive as they term it. That might be enough, if it could be given to every patient before the germs had time to cause

damage and destruction of lung and other tissue.

Case Reports Tell Story

The "case reports" tell the story of patients getting well with "unprecedented" speed. Here are a few examples:

A 21-year-old student nurse last October began having night sweats. She felt tired much of the time and lost weight. She began to cough, bringing up sputum, and her temperature went up in the afternoon.

She had caught tuberculosis, as many a young student nurse and intern does. X-ray pictures taken in November showed spots on her lung where the TB germs were causing damage. She was put to bed to rest, but the disease progressed swiftly. By Dec. 16 a thin-walled cavity had developed.

The next day daily treatment with streptomycin was started. One month later the germs had been licked. The cavity was no longer visible on X-ray pictures taken Jan. 17. Most of the shadows or spots of lung damage had cleared up. The young nurse was well on her way to recovery.

A 23-year-old Chinese man had been ill for several months with tuberculosis. For at least a month of the time, while he was getting the customary treatment for TB, rest in bed, he had a thin-walled cavity measuring almost an inch in his lung, and the cavity was surrounded by fluid.

Within six weeks after streptomycin treatment was started, the cavity had closed, the fluid had almost all cleared up, and TB germs could no longer be found in his sputum or in material washed from his stomach for testing.

After six months, during which the patient was allowed to get up and about and gradually to increase his daily exercise and activities, the cavity remained closed and no germs could be found in his sputum.

These patients might have gotten well without streptomycin, but they would have had to spend months, maybe years "curing" in a sanatorium. The TB-fighting chemical helped them recover with maximum speed. The kind of tuberculosis these patients had is being seen more and more frequently by doctors because of the increased emphasis on early diagnosis. It is a relatively uncomplicated form of the disease, but one which rapidly gets worse and is potentially serious. It is the kind in which streptomycin is expected to be of greatest usefulness.

Much more serious was the case of a 19-year-old colored girl who had rapidly progressive tuberculosis of the lymph glands in her neck. Within three months, the germs had attacked the membranes or sac around her heart. She was acutely ill but because of the heart condition, could not lie flat in bed.

Within five days after streptomycin treatment was started, her high temperature had dropped, and her symptoms "completely and dramatically" disappeared. So had the germs which had been found in the fluid around her heart, in the lymph glands and in her blood. Five months after treatment was stopped, she was without fever, without symptoms, and living at home where she could be up and about at least part of the day.

Only a few patients get over tuberculosis of the kind this young girl had.

When they do, it is after months of bed-rest. Ordinarily this girl would not have been expected to recover at all. The speed with which she did get well was, in the words of her doctors, "unprecedented."

These are descriptions from actual case reports of patients treated by Drs. Walsh McDermott and Carl Muschenheim of Cornell University Medical College and New York Hospital.

Details of Treatment

Suppose you had a friend with tuberculosis. Here is what is likely to happen to him, or her. First, his doctor would send him to a hospital, or sanatorium, for tuberculosis patients. Your friend may look well, to you. Some patients with TB fool you by their healthy appearance. But he is sick. He needs the rest and care that can usually be had only in a sanatorium. He needs, also, to be isolated from other people until he has passed the stage of spreading germs.

Whether he gets streptomycin will be a matter for his doctor's judgment. If he does get it, the drug will be injected into his muscle four, six or eight times every day. In these four to eight "shots" he will be given a total each day of three grams of material prepared from streptomycin crystals. The three grams represent about a tenth of an ounce by weight, though the streptomycin is dissolved in water for the injection. He will probably get these shots every day for 120 days.

If the germs in his body remain sensitive to streptomycin for that length of time, there is a good chance that at the end of that period they will have been stopped long enough for him to be on the road to recovery.

He will not be able to leave the sanatorium immediately. Damage to his lungs or other organs is not repaired by the drug, but must have time to heal. The germs may not have been completely stopped. They may stage a comeback. A period of waiting and watching for that is needed.

The important thing is that thousands who would inevitably die of certain kinds of tuberculosis will now have a chance to live. Thousands who would spend years "chasing the cure" may now get well in much shorter time.

TB Equals War Casualties

Death list for the war years, 1942-1945: 250,000 young men and women, in the United States, slain by the tubercle bacillus, one of our great public enemies.

Death list for the war years, 1942-1945: 250,000 young men killed in battle.

The war deaths have stopped with the winning of the peace.

Thanks to streptomycin, there is hope and promise that the continuing deaths from tuberculosis will be stopped.

This weapon that may be the atom bomb in the war against tuberculosis has been discovered in a chemical obtained from a kind of mold that lives in the soil.

Scientists are much farther ahead in fighting tuberculosis than they are in the war on cancer or on infantile paralysis.

It cost \$2,000,000,000 to produce the atom bombs that fell on Hiroshima and Nagasaki.

It has cost far less, so far, to pro-

duce enough streptomycin to treat a few thousand patients, even at the 10-months-ago price of \$40 to \$60 a day per patient. How much it will cost to end the war on TB (as effectively as the atom bomb ended the war in Japan) is not known. For one thing, the exact number of tuberculosis victims throughout the world is not known.

In the United States there are, according to best estimates, 500,000 patients with active tuberculosis. There are many more, actually and proportionally to population, in the rest of the world. We have 110,000 patients being treated in sanatoriums each year.

The war on tuberculosis, like other wars, has been costly in money as well as in human life. It has already cost the nation over a billion dollars to treat tuberculosis in World War I veterans.

The \$15,000,000 raised by the annual Christmas seal sale of the National Tuberculosis Association would, it has been said, pay for treatment of the nation's tuberculosis patients for only five days. According to another, more conservative estimate, the daily bill for tuberculosis treatment in the United States is \$1,000,000.

The cost of treatment is not the only dollars and cents cost of tuberculosis. To the medical bill must be added the loss in earnings of half a million persons, many of them in the most productive years of life.

Like the atomic scientists, the medical scientists who have developed a kind of atom bomb for the war on TB are afraid of what may happen to their weapon. Among themselves,

they are tremendously enthusiastic. In public, they are still so cautious and conservative that one of them was actually called a liar, though in a complimentary way.

Soviet Doctors Praise Waksman

That happened when Dr. Selman A. Waksman, discoverer of streptomycin, gave a speech about it before an audience of scientists in Moscow. At the end of his speech, a number of the Soviet Union's leading physicians embraced Dr. Waksman and presented him with flowers. Then one of them turned to the audience and said, smilingly,

"This man is a liar. He says that streptomycin only cures tuberculosis in guinea pigs. He says that it may not be a cure for humans. But we have a patient who was dying of tuberculosis meningitis. We gave that little girl streptomycin and now she is getting well."

Dr. Waksman and fellow scientists are cautious in their public statements about streptomycin because they fear that too much will be expected of the drug, and too many may be disappointed.

There have already been disappointments. Patients have been getting the drug for four, six, eight weeks and getting better. Fever goes down, coughing stops, cavities grow smaller. Doctors go on shooting the drug into them, hopefully, but after another week or two, the patient is sicker, instead of being well. The drug has lost its punch. The atom bomb for TB looks like a dud.

What has happened in such cases, generally, is that the TB germs have developed resistance to the earth mold

chemical. They are no longer stopped by it.

Disappointments have come in another way. The drug when first used for human patients was given to very sick ones. At first, some of them seemed to be helped. They felt better, fever went down, they regained their appetites and even a little weight. But the disease had gone so far that it could not be stopped, and the patients, some of them, died.

The trouble in those cases might have been too little of the drug. In the beginning, as with any new drug, doctors were not sure how big a dose to give. They could only calculate it approximately on a weight for weight basis. So many milligrams cured a two-pound guinea pig. For a 100-pound man, 50 times as much might be the right dose.

Some Bad Effects Observed

Some bad effects have followed use of streptomycin. Patients occasionally get skin rashes. Most uncomfortable and possibly serious of the toxic effects are the vertigo, which is a kind of dizziness, and the deafness which the drug has caused in some patients. Fortunately, these symptoms in most cases were not lasting. But they show that the drug should be used with care.

Curing tuberculosis involves more than stopping the germs that cause it. Cavities in lungs, open sores that are discharging pus, other damage to the body must heal, after the germs have been stopped by streptomycin.

This takes time and the patient needs rest and other treatment while the healing is going on.

As the latest discoveries are applied

and tested on thousands of patients, as they will be in coming months, the medical scientists will remember the long and often disappointing history in fighting tuberculosis.

Koch's Tuberculin

They will remember the great Robert Koch, discoverer of the germ of tuberculosis more than 50 years ago. From this germ, a slender rod of a microbe called the tubercle bacillus, Koch extracted tuberculin which he thought would cure the disease. Great were the hopes and bitter the disappointment when it was found that tuberculin, though valuable for diagnosing tuberculosis, was no cure.

Gold salts raised hopes as bright as the shining metal from which they were made. But gold treatment did not cure tuberculosis.

Many scientists with high hopes have made vaccines by treating living or dead tuberculosis germs, only one, the famous BCG, has had any widespread use or shown much value. Although extensively used in some countries, doctors in the United States have generally opposed it because it consists of living, though weakened, tuberculosis germs.

The fight against tuberculosis has not all been in vain. Discovery of its contagious nature and of means of detecting it early by X-ray and tuberculin testing have helped cut down its spread from patient to patient. Pasteurization of milk and inspection and testing of dairy herds have saved countless thousands of babies and children from lapping up the germs of this disease with their daily milk.

A Danish scientist, Finsen, and a Swiss, Rollier, took advantage of the

healing power of the sun's ultraviolet rays to treat thousands with tuberculosis of skin, bones and joints.

An American scientist, Trudeau, himself a victim of the white plague, "cured" himself and showed how to "cure" others by rest treatment which has since become standard for all tuberculosis patients.

Surgeons found ways of putting a diseased lung to rest by injecting air inside the chest until the lung collapsed. In severe cases they have not hesitated, with the development of modern surgical techniques, to remove pieces of rib and make the collapse of the lung permanent.

Sulfa Drugs Tried

When the sulfa drugs first were discovered, there was renewed hope of a chemical weapon against TB. Various sulfa drugs were tried and failed. Then chemists began manipulating the sulfa drugs, changing their structure, adding a bit of this and removing a bit of that. From such chemical manipulations came diasone, promin and promizole. The first of these, though showing promise as a stopper of TB germs, also soon showed itself too dangerous to human life. Promin and promizole were safe, but not as effective as doctors had hoped.

With the discovery of penicillin, or rather, with its rediscovery in the early days of the war, medical scientists had a new kind of germ-fighter. Penicillin and its sister drugs are known as antibiotics. They are chemicals made in the bodies of living organisms, or microbes, instead of in chemists' flasks and the dye vats.

Penicillin comes from a mold. Other

antibiotics come from other kinds of molds, from fungi, from bacilli which are more like the disease germs, and from plants. The tomato plant yields a chemical that checks disease germs. So does a kind of lichen known popularly as California Spanish moss.

Today it is the "sister" of penicillin, a germ fighter from mold, called streptomycin, that is the great hope for conquering tuberculosis. There is high hope that this time the disease is on the run, pursued by the joint skill of the chemist and the physician.

Better Antibiotics Possible

There is the promise of bigger and better streptomycins which scientists are already seeking and may even have found.

Grisein, a close relative of streptomycin; another chemical from a lichen; others from other plants and microbes are coming out of the laboratories for testing. When TB germs grow resistant to streptomycin, one of these others might take over and finish the "cure."

Because there are half a million tuberculosis victims in the United States alone, with the cost of their treatment running to a million dollars a day or more, the spending of 50 or 100 million dollars a year in the search for bigger and better "magic bullets" against the white plague would not be exorbitant.

In bringing streptomycin through its first trials, private laboratories and clinics, the manufacturers, the National Tuberculosis Association and the American Trudeau Society, the Veterans Administration and the U. S. Public Health Service have all helped. Brains and money from these

sources have gone into the common task of building what looks like the atom bomb for the war on tuberculosis.

More of both are still needed. Treatment of just one patient, even at today's lower price for streptomycin, may cost \$1,200 for the drug alone.

Licking the problem of germ-resistance to the drug will take money for equipment and trained personnel.

Finding ways to prevent the skin rashes, dizziness and deafness which occasionally come to the patient under prolonged treatment with streptomycin calls for more money.

Putting the new sister-drugs to

streptomycin through their tests cannot be done without men and money.

When it comes to saving human life, however, money becomes a minor factor. If the money is not available, Congress may be called on to implement this promising line of research, just, as during the war, the government tackled the atomic energy research problem.

In this case, there will be no need for secrecy. The whole world may know and rejoice over this research. There will be no need for international watch dogs to control the results. The whole world may share and benefit from them.

Fuel for a Thousand Years

► THERE will be plenty of gaseous and liquid fuels available in America for a thousand years or more.

The American Society of Mechanical Engineers was given this forecast by Arno C. Fieldner, chief of fuels and explosives of the U. S. Bureau of Mines.

These fuels may not be petroleum products, however; they will be derived from coal and lignite, of which there are abundant reserves. Production from these sources will increase as the reserves of petroleum and natural gas approach exhaustion.

Coal and lignite can be converted into gaseous and liquid fuel, and have been so converted for many years. Processes and equipment for this purpose have been developed, and the costs are known. In recent years, in Germany in particular, processes have been put into commercial operation for the

manufacture of liquid fuel from coal and from lignite.

Mr. Fieldner estimated the known fuel reserves of the United States at an energy equivalent to 2,600,000,000,000 tons of bituminous coal. Approximately 55 per cent of this solid fuel is high-volatile bituminous coal, 23 per cent subbituminous coal, 19 per cent lignite, 2.5 per cent low-volatile bituminous, and 0.5 per cent anthracite.

A declining supply of petroleum can be supplemented also by alcohol from the fermentation of vegetable matter, conversion of natural gas by the gas-synthesis process, and the distillation of oil shale.

The cost of fuels from coal and lignite will be greater than the present cost of petroleum and natural gas, but future developments in the more efficient utilization of fuels should go far in offsetting the cost of conversion.

Are Scientists Trying to Convert Hydrogen to Helium?

Progress in Atomic Science

► THE PUBLICATION in the *Infantry Journal* of a hint by former Assistant Secretary of War John J. McCloy that we were working on a new kind of atomic bomb started a new wave of speculation.

The big question is: Is serious work being done here on earth to try to duplicate the conversion of hydrogen into helium with release of atomic energy which keeps the sun stoked?

Going to the famous Smyth report, the atomic energy bible, anyone can read that this sun energy theory was advanced by Prof. Hans Bethe, now professor at Cornell and one of those who worked on the atomic bomb. The heat of the sun is explained by a cycle of nuclear changes involving carbon, hydrogen, nitrogen and oxygen, leading eventually to the formation of helium. This theory "is, the Smyth report says, "generally accepted."

Since hydrogen, the lightest element, is very abundant, and uranium and thorium, now the raw materials for atomic bombs, are very rare, so much so as to be controllable internationally, any practical success at duplicating on earth what presumably happens in the sun would have extraordinary results scientifically and politically.

The best guesses have been that the carbon-stove reaction, as the Bethe suggestion is also called, will not

work except at the immense temperatures of the sun. Unless such temperatures are created in the conventional plutonium atomic bomb itself, sun temperatures don't exist on earth.

It may be fair speculation that an atomic bomb such as already used might provide the conditions to start the intricate and involved conversion of hydrogen into helium and positrons with release of energy. This is, of course, mere speculation.

This is the way the Bethe cycle is believed to work:

An ordinary carbon atom atomic weight 12 picks up a hydrogen atom of mass one and becomes nitrogen 13, which shoots off a positive electron or positron to become carbon 13, which in turn takes up a hydrogen atom becoming nitrogen 14. This atom adds a hydrogen atom to become an unusual oxygen 15, which expels a positron, which changes it into nitrogen 15. This heavy-weight nitrogen joins with another hydrogen atom to make the same kind of carbon atom that began the cycle, plus a helium atom of an ordinary sort.

The total effect is the use of four hydrogen atoms to make a helium atom, two positrons and a release of about 30,000,000 electron volts of energy. Chemists have long known that four hydrogen atoms have a slight excess of mass compared with the helium atom of atomic mass 4, and it is this excess of mass that is turned into energy according to the

famous Einstein mass-energy equation.

Uranium from Oil Shale

► URANIUM, used in generating atomic energy, is one of several by-products obtained in producing oil from shale in Sweden, the American Chemical Society was told.

Dr. Gustav Egloff, director of research of the Universal Oil Products Company, has reported to the American Chemical Society that shale is radioactive and contains about 220 grains of uranium oxide per ton, or nearly half a pound. It contains also aluminum, vanadium and molybdenum, valuable products for which the Swedish government is seeking profitable uses in an effort to make the shale-processing program self-sustaining.

Progress in producing oil from oil shale in any part of the world is of interest in America because the United States has an estimated 100,000,000,000-barrel oil reserve in its shale which will rapidly come into use as natural petroleum reserves decrease. Industrial production of shale oil in Sweden is centered in a \$25,000,000 plant at Kvarntorp, where 2,000 barrels a day are refined. The residual spent shale is used as fuel in boilers for the generation of electricity.

Heat from these electric heaters is used to force oil up out of the shale through pipes in the form of vapors, he stated. Temperatures required are near 1,000 degrees Fahrenheit, and it takes three months to heat the deposit. Two months are then required to distill the underground shale. Normally, about 30 years would pass

before the earth had cooled to its original temperature. While heated, the soil produces vegetation at unusual speeds and of greatly increased size.

No Atomic Power Before 1960

► Low cost atomic power will not be available before 1960.

Dr. Henry T. Wensel, chief of the scientific branch of the research group of the War Department General Staff, and Dr. Ralph E. Lapp, scientific adviser of the scientific branch, state that engineering problems must be solved before the power of the atomic bomb can be turned to power use. The two big problems are getting structural materials which will withstand the high temperatures of the atomic pile and developing methods of getting the heat out of the system.

An atomic power pile will not explode like an atomic bomb, but unless the heat is conducted away fast enough, the pile would melt. The first practical power piles will not compete with coal or oil and they will undoubtedly be used for special applications where the cost of the power does not prohibit use.

Atomic power for naval vessels and for use in out-of-the-way places where other fuels are not available, such as perhaps the Antarctic, were suggested by the atomic scientists as early applications.

The atomic power plant being built at Oak Ridge, Tenn., is the first model of a nuclear machine to produce useful amounts of power.

When atomic power is perfected, a plant big enough to supply a city of 10,000 persons could be housed in a relatively small two-story building.

Atomic power piles of the future will use enriched uranium 235 and be much smaller than the massive Hanford, Wash., plant which runs on natural uranium.

Atomic power for aircraft is forecast, and the most serious problem will be shielding against harmful radio-activity. It would take about 50 or 75 tons of shielding material for a 10,000 horsepower atomic engine.

Before atomic power plants can produce low-cost power, radioactive isotopes from atomic energy piles will be put to many important uses by scientists.

With radioactive materials there will be found new knowledge of medicine and biology, mass air movements and weather, food chemistry and packaging techniques, vacuum tubes, food chemistry, ocean currents and other fields.

Hydrogen in Atomic Jets

► ATOM-POWERED rockets of the future may use liquid hydrogen to translate the radiant energy of uranium into terms of propelling push, Rear Adm. William S. Parsons, Navy Director of Atomic Defense, has suggested.

The hydrogen will not be burned as fuel, but merely be converted back into gas, which will be heated to incandescence and expelled through the nozzles at tremendous velocity. Outside, it will of course unite with atmospheric oxygen, giving the rocket a flaming tail; but this will not add anything to the propelling power.

This mode of rocket propulsion, first suggested by Dr. Luis W. Alvarez, seems possible because of one

physical law of rocket propulsion: that the lightest atoms have the highest momentum at any given temperature. Hydrogen, being the lightest of elements, would be best to use for theoretical reasons. Fortunately, practical reasons back it up: hydrogen is plentiful, cheap, easily liquefied and easily handled.

Outstanding difficulty about using atom-powered rockets is the terrific expense in terms of hard-to-get uranium, whenever a rocket goes astray and is not recovered.

Long Life Radioiodine

► A NEW long-life radioactive iodine has been produced by bombarding the chemical element tellurium. Instead of the relatively short existence of the usual radioiodine used in medical treatments, the new synthetic iodine is believed to have a half-life of either 10 or 400 years.

Iodine isotope 129, hitherto missing from accepted tables, was made by bombardment with hearts of heavy hydrogen or deuterons speeded to 14,500,000 electron-volts in the MIT cyclotron. Dr. Allen F. Reid, at Columbia University when the experiments were made, and Dr. Albert S. Keston of New York University, report their discovery in the Physical Review.

Radiotracer for Fertilizer

► RADIOACTIVE phosphorus is now being produced at Oak Ridge in sufficient quantities to permit relatively large-scale use in field tests on the fertilizer needs of plants. Such tests are already under way, supported by funds supplied by more than a score of fertilizer manufacturers.

The radioactive material is thor-

oughly blended into ordinary super-phosphate fertilizer, which is then applied to the soil in experimental field plots and in greenhouses. Where the fertilizer goes, and how fast it gets there, can be determined by using Geiger counters on the growing plants.

One of the chief objectives of the research is to find out, if possible, why so much phosphate gets lost. On an average, only about one-fourth of the phosphate put on the soil as fertilizer is taken up by the plants; the rest is dissipated in various ways. The scientists hope eventually to raise the efficiency of phosphorus utilization.

The work is being done under the general direction of Dr. Ralph W. Cummings of the North Carolina Agricultural Experiment Station at Raleigh. Tests are also being conducted at the New York State Experiment Station at Ithaca and at the great proving-ground of the U. S. Department of Agriculture at Beltsville, Md.

Radio Signal from Nucleus

► THE NUCLEUS of an atom is turned into a miniature radio transmitter, sending out a signal that identifies

the atom, in a new technique developed by Dr. Felix Bloch in collaboration with Dr. William W. Hansen and Martin Packard, all of Stanford University.

Amplified radio frequencies reproduced on an oscillograph screen show the observer what frequency the atom responds to. Each element has a characteristic frequency to which it resonates in a magnetic field under the influence of radio-frequency electric current.

Test materials are first placed in tiny glass vials in the field of a powerful electro-magnet. Spinning the vials in the magnetic field induces a radio-frequency current into the nuclei of the atoms. When the nuclei are spinning at right angles to the field, the frequency of the signal from the atom can be determined by a sensitive receiver, revealing the identity of the element.

The nucleus of a hydrogen atom, a proton, will whirl as fast as 42,500,000 times a second in a powerful magnetic field. Dr. Bloch has been using protons in his testing which has revealed the hydrogen in solution or in paraffine. The technique is not yet ready for practical scientific work.

Phosphors Chemically Pure

► ZINC SULFIDE, zinc silicate, calcium sulfide, strontium sulfide and certain tungstates are the most popular phosphors used in television tubes, paint pigments and other applications.

Dr. J. R. Spraul, Armour Research Foundation, has stressed the necessity

of chemically pure substances if satisfactory results are to be obtained.

Phosphors are luminescent materials used to convert invisible ultraviolet rays, X-rays and cathode rays into invisible light.

Right in Ground, Without Mining, Burn Coal and Distill Oil Shale

Underground Power Production

➤ CHEMISTS and engineers are getting ready to take over nature's job of manufacturing gaseous and liquid fuels such as now come out of the oil and gas wells drilled deep in the earth.

When the gas wells lose their pressure and the oil wells run dry, coal and oil shale can furnish the gas and petroleum-like fuels so necessary to our civilization.

Two promising methods are being used on a commercial scale:

1. Burning coal without removing it from the ground. Gases for heating purposes and for liquid fuel manufacture are obtained.

2. Distilling underground oil shale by electric heat right in the beds where the shale is found.

Both in America and Russia, the coal-burning process is now producing a gas from which liquid fuels can be made.

In Sweden petroleum products are being obtained from oil shale by the electrical underground heating method.

The American experiment with underground coal, initiated just a few months ago, is being conducted by the U. S. Bureau of Mines in cooperation with the Alabama Power Company, at the Gorgas mine near Jasper. The gas secured can be used for direct heating under boilers in industrial plants, as well as for a source of gasoline and lubricating oil.

The process of underground gasification of coal by burning will permit the use of impure deposits and of coal seams too thin to mine. It would result also in a more complete recovery of the coal from a mine; present mining methods now leave from 35% to 50% of the material in the ground.

In the Alabama experiment, two horizontal holes six feet wide were dug down into a 2½-foot coal seam and connected by a crosscut. Several small holes were drilled from the surface into the coal seam to take gas samples and temperature readings. Combustion was started by dropping incendiary bombs down several of these holes. To create a draft and provide oxygen for combustion, air was forced down one of the dug holes which passed through the crosscut, and the resulting gases were collected at the mouth of the other.

At times a limited amount of oxygen was used to enrich the air forced through the crosscut. Also a relatively high-grade synthesis gas was produced by alternately blowing air and steam into the burning mine. The method is similar to an underground gasification system employed in Russia. The Russians are said to be using an oxygen-enrichment process, also.

In the Swedish system of getting the oil out of oil shale without mining and transporting tons of earth to a refinery, holes are drilled 50 feet into the stratum of shale deep down under its covering of other rock and earth,

and electrical resistance heaters are lowered into them.

In about three months the shale is properly heated and oil vapors, distilled out of the oily ground, arise through the holes. These are gathered by pipelines and refined. In some two months no further vapors appear, and the apparatus is moved to a new site.

The method appears to be expensive because of the large amount of power required to develop the electricity and keep a constant quantity of heat in the shale during the five-month period. It may, however, prove economical for Sweden, which has no natural petroleum deposits and has an abundant opportunity to develop elec-

tric energy by hydroelectric plants. Sweden, cut off from practically all gasoline imports during the war, now has a seemingly possible method of preventing such a situation from arising again.

In the United States, the method appears to be less practical, and the Bureau of Mines, in its work of obtaining gasoline oils from oil shale, is following mining practices, transporting the mined material to refineries for processing. Mining oil shale is relatively easy in America because this country has much outcropping shale. Also, no great hydroelectric installations have been made in the areas where the oil shale is most plentiful.

Phosphorus For Growth

► A "CHEMICAL "workhorse" which makes phosphorus available to the growing embryo has been discovered in research at the University of California.

This agent is an enzyme which liberates phosphorus from protein in the eggs of frogs, so that the embryo can use it in its development.

This is the first time such an enzyme has been reported. Now that the mechanism is known, scientists may find similar enzymes in higher animal forms, including man.

The research was done by Dr. Daniel Harris, formerly of the department of biochemistry at Berkeley and now at California Institute of Technology, who was studying the enzyme make-up of protoplasm. Using frog

eggs, he noticed a big increase in the inorganic phosphorus content when the eggs were ground up. He traced the cause to the new enzyme, which is called phosphoprotein phosphatase.

The find may prove of immense value, in that phosphorus is essential to normal growth in all living tissue. Phosphorus is found in the nucleoproteins, the basic substances of the cell nucleus; probably in chromosomes, heredity-determining units; and even in viruses.

The ovum is a storehouse of phosphorus, and the new research indicates that when the embryo is in need of phosphorus the enzyme pries it loose from the protein substances in which it is locked.

Over 20,000,000,000 tons of bituminous coal have been mined in the United States, but this is only two per cent of the estimated reserves.

Frivolous Effervescence and Caustic Comment

by OUR READERS

► Miss I. M. S., who is a technical librarian, urges that profession for young people with scientific training. She finds that "it is an angle which has been overlooked in past years by most heads of departments of chemistry. They could do a great deal in presenting the desk job picture in a more favorable light. Most chemistry majors have thought only in terms of the laboratory."

* * *

► "I APPRECIATE your magazine very much," writes Mr. C. W. U., Tilson, N. Y. "The articles are very interesting and open the soul to new possibilities, and I hope to be a subscriber for many years."

* * *

► "CHEMISTRY looks to me like a most meritorious venture," says Dr. C. L. B. of Wilmington, Del. "It should help in developing candidates for your Science Talent Search program, for industry and perhaps even for some future Nobel Prize winner."

* * *

► "I FIND it a magazine well prepared and easy to understand," says Mr. E. W. F. of Chicago. "Keep up the good work, for I feel that chemistry is going to play a very important role in the coming years."

► "I WOULD like to take this opportunity," says Mr. E. F. L. of Indianapolis, "to express my delight at the several improvements that have been effected in Chemistry since I first subscribed to it. I think your section on patents is most interesting as is the monthly series of experiments by Burton Hawk."

* * *

► "How CAN I remove nitrogen or NO_2 compounds from a solution of lithium carbonate? Nothing I have seems just to fit. It contains other impurities, which I think I can remove. It contains 0.03% Cl which I can precipitate and remove with AgNO_3 , 0.2% SO_4 which I can remove with BaCl_2 , 0.003% Pb which I can remove with H_2S , 0.002% Ba which I can remove with ammonium carbonate, 0.03% other alkalies as chlorides, which I can remove with AgNO_3 , 0.005% iron, which I can remove with ammonium carbonate. It also contains 0.001% nitrogen compounds. How can I remove that? I can't find it in my Analytical Chem. course."—R.M.B.

We do not know whether the rules Miss B. has set up for herself allow her to crystallize out her lithium carbonate and leave the impurities in solution, or whether this is purely an exercise in precipitation, but have any analytical fans any tricks that would help her?

For the Home Lab

The Hot-Headed Halogens

Bromine

by BURTON L. HAWK

► THE NAME of bromine is derived from the Greek, meaning "a stench." And after you have performed this experiment you will no doubt agree that it has been appropriately named. Not only is the odor disagreeable, but also very irritating to the eyes and respiratory tract. The liquid itself is extremely caustic and if spilled on the skin will produce severe burns which are liable to become infected and are slow in healing. All in all, a rather unpleasant substance!

But the scientist cannot disregard certain substances simply because they have offensive properties. Coal tar is a dirty, sticky, foul-smelling mixture with which it is most disagreeable to work. However, consider the rich harvest reaped from the seeds of pains-

taking research on this obnoxious substance!

Turning from the philosophical to the practical, let us proceed with the preparation of bromine. The chemical properties of bromine are similar to those of its older brother, chlorine, although not quite as energetic. Therefore it is possible to displace bromine easily from its compounds with chlorine. The chlorine is prepared by adding 5 cc. of dilute hydrochloric acid to a small quantity of manganese dioxide in a test tube. Attach a stopper and delivery tube extending below the surface of a solution of potassium bromide in another container. (Fig. 1). Now heat the test tube slightly, allowing the gas to bubble through the bromide solution. Bromine is immediately set free and imparts a deep orange color to the

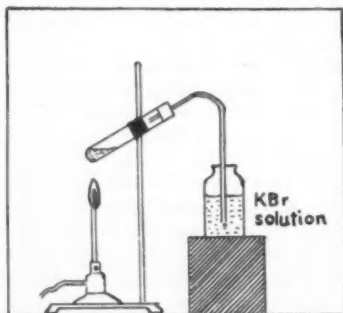


Fig. 1. Displacement of bromine.

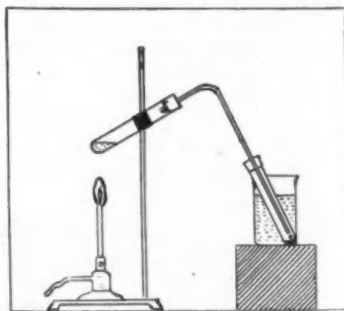


Fig. 2. Preparation of bromine.

solution. This aqueous solution is *bromine water*. The chlorine passes into solution as potassium chloride.

Free bromine forms a yellow color with starch which you can easily demonstrate. Prepare a starch solution by adding a pinch of starch to 25 cc. water, boiling a few minutes, then thoroughly cooling. Add to a portion of bromine water.

Similar to chlorine, bromine water also bleaches. Prepare three solutions by boiling logwood, cochineal, and litmus in water. Add a little bromine water to each of the three colored solutions.

As chlorine displaces bromine, so bromine displaces iodine. Dissolve about $\frac{1}{2}$ gram potassium iodide in 10 cc. of water and add bromine water. Notice the violet coloration as iodine is set free. Adding a few drops of this solution to starch solution will form the intense blue color offering further proof of free iodine. We will investigate the properties of iodine more thoroughly in a future experiment.

While bromine is fairly soluble in water, it is much more soluble in carbon disulfide, carbon tetrachloride, chloroform, ether, and similar organic solvents. Pour a few cc. of carbon tetrachloride in bromine water and shake thoroughly. After allowing to settle, note the deeper brown color in the layer of carbon tetrachloride. The same holds true for the iodine solution previously prepared. Here the carbon tetrachloride will be colored a lovely violet.

So far our attention has been focused on bromine water. Now we

shall attempt to prepare the element itself. Again caution must be stressed. Many young lab enthusiasts tend to disregard warnings as they become more experienced and confident in experimenting. Confidence is an admirable trait, but it can also lead to carelessness!

Place a *small* quantity—about $\frac{1}{4}$ gram—of manganese dioxide and an equal quantity of potassium bromide in a test tube. Add a few cc. of dilute sulfuric acid. Attach a stopper and delivery tube leading to a test tube immersed in a tumbler of cold water. (Fig. 2). Upon heating the first tube, deep clouds of brown vapor will be driven off and condense to a dark red liquid in the receiving tube.

Bromine combines directly with many metals but less vigorously than chlorine. Throw a piece of magnesium ribbon in the bromine. It will dissolve quickly, forming a white powder which is, obviously, magnesium bromide and finds use in medicine as a sedative.

Bromine first came to light in the year 1826, introduced by Antoine Jerome Balard who obtained it by adding chlorine to brines and distilling. It is interesting to note here that the great chemist Liebig almost discovered bromine. Earlier he had acquired an unknown substance, and upon testing not too thoroughly, he concluded that it was a compound of iodine. When the properties of bromine were made known by Balard, Liebig realized they were identical with his substance. His "compound of iodine" was actually bromine!

Supersonic Wind Tunnel Duplicates Conditions in Sky

Upper Air Laboratory

► A STRIP of the sky from 100 miles overhead will be brought down into the laboratories of the University of California.

Two new supersonic wind tunnels under construction will create conditions in a 90-mile mystery belt of the sky from altitudes of 50,000 feet to 100 miles for studies of high-speed flight.

Jet-powered, the two tunnels are being built with funds provided by the Office of Naval Research. A pilot model will duplicate conditions up to 70,000 feet, while a larger tunnel, three inches square, will test models in conditions up to 50 miles high and at speeds five times as great as the approximately 760-miles-per-hour speed of sound.

Streams of molecules fired at models by a yet-to-be-designed molecular beam apparatus will create conditions found from 50 to 100 miles overhead.

The new tunnels are based on war-developed vacuum and jet propulsion principles. Instead of the conventional blowers of wind tunnels at or near sea level conditions, the high-altitude, supersonic tunnels will be powered by a steam jet vacuum pump, the most suitable device for handling the required large volumes of air at low pressures.

The part of the sky to be studied in the laboratory with the new wind tunnels is the mystery belt of space. Scientists have well-developed physical laws for conditions up to 50,000 feet

high, and the influence of temperature and other conditions on atoms and molecules above 100 miles has been determined fairly well.

But the region in between is largely a mystery as far as the principles of fluid flow at supersonic speeds are concerned. This problem of flight at high speeds and high altitude is to be tackled with the new wind tunnels.

Dr. R. G. Folsom and E. D. Kane of the University of California School of Engineering are in charge of the project.

Mr. Kane explained that bringing the sky into the laboratory with the wind tunnels is more effective than firing rockets or other missiles into the upper atmosphere, because the effect of the air at high altitudes on the instruments is not known.

He said the mysteries of the high-altitude regions cannot be solved by wind tunnels which operate at temperatures and air pressures at or near sea level, because there are fundamental differences in the air. One of these is the change in the number of molecules at sea level and high in the atmosphere. Molecules are much less frequent in the air at high altitudes.

First studies of supersonic speeds in the new tunnels will be made at conditions of altitudes below 50 miles.

Captured German documents have disclosed that the Nazis had a wind tunnel similar to the ones being built here. It was for testing flight conditions at speeds less than sound.

Patents, Chemically Speaking

Week by week the Patent Office Gazette tells what brain children of our scientists and inventors have been given letters patent. CHEMISTRY presents a selection of some of the thousands granted. To get a copy of a patent, send 25 cents, not check or stamps, to the U. S. Commissioner of Patents, Washington 25, D. C., and order by number.

Rhenium By New Process

► RHENIUM, one of the more recently discovered elements, may become more plentiful as a result of the development of a new process by two University of Tennessee chemists, Prof. Arthur D. Melaven and Dr. John A. Bacon. U. S. patent 2,414,965 has just been issued on this, and is assigned to the University of Tennessee Research Corporation.

Rhenium exists in some sulfate ores in very low concentrations—usually only a fraction of one percent—and comes off with the flue dust in the roasting process. This dust, collected by electric precipitation, contains the element in the form of rhenium heptoxide. This can readily be removed by solution in water and filtering. Addition of any soluble compound of potassium brings down the rhenium in the form of an insoluble salt, potassium perhenate, which may then be subjected to further purification.

Rhenium, discovered in Germany in 1925 by Drs. Walter and Ida Noddack, makes a good hydrochloric-acid-resistant coating on metal containers.

It may find other uses once a larger supply becomes available.

Desulfuring Hydrofluoric Acid

► HYDROFLUORIC ACID, highly corrosive compound much used in the production of leaded gasoline, is freed from the hampering presence of sulfur dioxide simply by reacting it with hydrogen disulfide, in a process patented by Dr. Maryan P. Matuszak of Bartlesville, Okla.

The oxygen in the sulfur dioxide unites with the hydrogen of the hydrogen disulfide to form water, the sulfur from both compounds falls out as finely divided solid, and the acid can be removed by distillation. Patent 2,414,884, issued on this process, is assigned to the inventor's employing firm, the Phillips Petroleum Company.

New High Explosive

► A NEW HIGH explosive, particularly suitable for use as a secondary detonator, is di-iso-propanolamine trinitrate, which might appropriately be short-handed as DPAT. In patent 2,415,001, issued to John D. Brandner, an Atlas Powder Company chemist, it is described as a white crystalline solid, melting at 119.6 degrees Centigrade, soluble in hot water, resistant to shock and friction but readily set off by the primary detonators. Rights in the patent are assigned to the company.

Glycerin by Fermentation

► IMPROVEMENT in the production of glycerin by yeast fermentation of hy-

drolyzed starch is claimed in patent 2,414,838, granted to Arthur L. Schade of New York and E. Farber of New Haven. They bubble air or other non-poisonous gas through the fermenting mash, removing carbon dioxide, alcohol and other volatile products, which are subsequently recovered. Patent rights are assigned the Overly Bio-Chemical Research Foundation, Inc., of New York.

Blower Without Motor

► A HEATING DEVICE that runs its own warm-air blower, asking no help from the house electric current, is covered by two newly-issued U. S. patents, 2,414,830 and 2,415,064, issued to the estate of the late Henry J. DeN. McCollum of Chicago.

The trick is to burn the fuel in a rotating burner, which has a blower fan mounted on the same shaft. In one form of the invention the rotating burner is a simple gas turbine, with the heat exchange to the air circulation going on through walls of a long exhaust tube. In an alternative form, compactness is gained by making the turbine also the heat-exchanger. In both forms, a small electric generator is also mounted on the shaft, to insure continuous ignition of the gaseous fuel by means of spark plugs.

Rights in both patents have been assigned by the inventor's executrix, Thelma McCollum, to the Stewart-Warner Corporation.

Machine Applies Ammonia

► A FARM MACHINE for the simultaneous application of atomized ammonia fertilizer and soil fumigants to combat fungi or kill nematodes or insect larvae is protected by patent 2,415,251, assigned to the Shell Development

Company by its inventor, Floyd H. Leavitt of Burlingame, Calif. The soil-benefiting liquids are atomized with compressed air or other gas, and let out into the soil through nozzles drawn along under the surface.

New Sulfuric Acid Process

► SULFURIC ACID, which may be said to be the keystone in the arch of chemical industry, is made with greater efficiency and economy through a process on which two Canadian chemical engineers, I. R. McHaffie and H. R. L. Streight, both of Montreal, have received patent 2,415,142. In this, the initial input of wet sulfur dioxide is thoroughly dried by passage through concentrated sulfuric acid before it is converted into sulfur trioxide preliminary to final conversion into sulfuric acid. The water absorbed by the acid in the drying towers is removed by contact with the hot, dry waste gases coming off at the final stage of the process.

Thermal Production of Chlorine

► CHLORINE, another indispensable element in chemical manufacturing processes all the way from bleaching cloth to making synthetic rubber, goes back to the thermal method of production in the process on which Alfred M. Thomsen of San Francisco has obtained patent 2,415,152. His process resembles two that were in use before present-day electrolytic methods superseded them, but avoids the difficulties that made the old methods obsolete. Critical step is the use of fragments of firebrick superficially impregnated with frequently renewed layers of cupric chloride as catalysts in the oxidation of hydrochloric acid to chlorine and water. Spent gases from the heat-

ing process involved in the impregnation are used to raise the temperatures of the gases involved in the process.

Benzol to Phenol

► PHENOL, basic alike to plastic resins and disinfectants, is produced by the oxidation of benzol vapor in the presence of heat and a catalyst, in the process on which patent 2,415,101 has been granted to R. H. Krieble of Schenectady and W. I. Denton of Woodbury, N. J., assignors to the Socony-Vacuum Oil Company. An essential step in the process is continuous addition of fresh benzol with impurities containing paraffin, cyclohexane, etc.

Insoluble Nitrogen Fertilizer

► WAR-CAUSED famine in Europe is focusing attention on problems of production of food, and of fertilizer that helps make food. Timely interest thus attaches to a new kind of nitrogen-containing fertilizer, covered by newly-issued U. S. patent 2,415,705.

One difficulty with all nitrogen fertilizers now in use is their high solubility, which permits rain or irrigation water to leach them out of the soil very rapidly. A rain-insoluble fertilizer, in which the nitrogen is still available to plant roots, has long been a great desideratum among agronomists.

This problem has been met by L. V. Rohner of Syracuse and A. P. Wood of Geddes, N. Y., who make a water-insoluble resin by compounding urea and formaldehyde, adding ammonium nitrate (another high-nitrogen compound) during the process to bring the mixture to a desired degree of acidity. After washing and drying, the resulting resin is finely ground and bagged for shipment. Patent rights

have been assigned to the Solvay Process Company.

Lignin as Purifier

► USE OF that Cinderella of the plant-products world, lignin, as a means for purifying beet and sugar-cane juices before concentration was developed by W. D. Nelson of Reserve, La., for patent 2,415,439. Lignin, dissolved out of bagasse or other wastes with alkali, is added to the crude juice, then coagulated with lime and heat, trapping trash and impurities.

Wine Aging Process

► SPEEDED-UP aging of wines is the object in a process covered by patent of San Francisco. Aging-in-wood, he 2,415,431, granted to Ernest T. Krebs states, benefits wines and liquors mainly by exposing them to the enzyme action of wood-inhabiting fungi, particularly those of the black-mold family, which destroy undesirable acids, tannins, higher alcohols, and the like. So he greatly increases the availability of these desirable molds by growing them on shavings, wood chips, etc.

Vegetables De-aerated

► VEGETABLES being prepared for dehydration are customarily blanched by scalding in hot water or steam. This is done mainly to destroy enzymes that would otherwise spoil colors and flavors by oxidation. This oxidation-spoilage problem is met in a different way in a process on which U. S. patent 2,415,995 has just been issued to Harold K. Derby of Berkeley, Calif. Rights in the patent have been assigned to F. E. Booth Company, Inc., of San Francisco.

Instead of destroying the oxidizing enzymes, he removes the oxygen with-

out which they cannot function. This is done simply by putting the vegetables under water in a closed vessel and exhausting the air with an aspirator. After all the air has bubbled out of the vegetables, air pressure is re-admitted to the vessel, sometimes with extra air pressure added. This fills up the evacuated air spaces in their tissues with water, which is subsequently removed, along with their own natural water content, in the dehydrating process.

Chemical "Frost" for Cotton

► FAILURE of cotton bolls to open up all at the same time has been one of the main problems of cotton picking, whether by hand or machine. Noting that a light frost, sufficient to cause the leaves to fall off, also causes unopened bolls to hasten their maturity and come open, Dr. John F. Kagy and D. T. Prendergast of Long Beach, Calif., sought a chemical that would have the same effect. This they found

in an organic compound known as pentachlorophenol, applied as a dilute spray. Patent 2,416,259, covering this process, has been assigned to the Dow Chemical Company.

Iron Helps Torch

► SQUIRTING a stream of fine iron particles coated with oxide into the flame of an oxy-hydrogen steel-cutting torch hastens the operation. The inventor, G. M. Deming of Orange, N. J., explains that the oxide coating prevents the particles from igniting prematurely. Rights in his patent, No. 2,415,815, are assigned to the Air Reduction Company, Inc.

Vitaminized Developer

► ADDITION of a vitamin to photographic developer is reported. Arnold Weissberger and Hugo A. Kurtzner, Eastman Kodak Company chemists, explain that ascorbic acid which is vitamin C slows down oxidation. The patent is No. 2,415,666.

More Chemicals From Wood

► MORE charcoal obtained from wood, also more acetic acid and methanol, by a new process was described to the Northeastern Wood Utilization Council in Boston by Robert S. Aries of the Polytechnic Institute of Brooklyn where it was developed.

One ton of dry wood, under the new process, yields 1000 pounds of charcoal, 125 pounds of acetic acid, and 80 pounds of methanol. This is roughly two-thirds more than obtained by present oven methods.

The Institute's new method employs a steel chamber into which the wood is fed at the top and emerges as char-

coal at the bottom. Flue gases are circulated several times in the chamber, thus drying the wood and saving on the amount of heat necessary for carbonization. In the ordinary process, wood is loaded by hand onto cast iron cars and run into a heated kiln.

Commercial charcoal makers ordinarily can not operate economically without an income from the by-products including acetic acid and methanol. These essential chemicals can now be made synthetically. The larger yields by the new process will help the charcoal producers in the competition.

Chemical Magic

Powder Makes Things Unwetable

by JOSEPH H. KRAUS

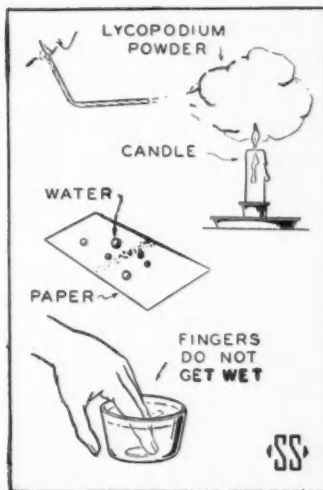
► MANY ODD experiments can be performed with lycopodium, a yellowish spore powder. In large quantities the powder will not burn, but when it is finely divided it will burst into flame if ignited. It will keep water from wetting paper and will enable you to remove coins from a glass of water without getting your fingers wet. Consisting of spores of club-mosses, lycopodium powder is sometimes used by pharmacists to cover pills which otherwise would tend to stick together.

Only a small quantity of lycopodium is needed for this experiment. You can buy it from an old-fashioned pharmacist or chemical supply house.

Pile a small quantity of this powder on a spoon or metal ash tray, then try to set it on fire with a match. You probably won't be able to get the heap to burn. But lycopodium will burst into flame when well separated, as the following experiment shows.

It is best to do this experiment out-of-doors. Should you have to work inside, beware of flimsy curtains, because when this dust is suddenly released in a small, confined space you have an excellent example of a miniature dust explosion.

Bend a soda straw sharply at the middle and fill one end of the straw with lycopodium powder. Then straighten the straw slightly, being careful not to spill the powder. Light a candle. Standing at least two feet



away from it, blow the powder toward a point two feet above the flame. There will be a sudden large flash of yellowish flame. Jump back quickly.

Remove Coin from Glass

Now ask your friends to remove a coin from a glass of water without getting their fingers wet. Unless they know the secret, they will find this quite impossible to do. But you can keep your fingers dry if you sprinkle just a little lycopodium powder on the surface of the water. This will enable you to put your fingers into the vessel and remove the coin. Although the coin will be wet, the thin film of powder which envelopes your fingers will keep them perfectly dry.

Place a small quantity of lycopodium powder on a sheet of paper and let a drop of water fall on the powder. Move the drop around until it picks up a thin coating of the powder; it will become a perfectly round ball. The drop can be made to roll around on a sheet of writing paper without getting it wet. A number of such drops remain spherical and keep their individuality although they may bump into each other. They will bounce around like droplets of mercury for a surprisingly long time.

Now blow into an empty drinking glass or paper cup to coat it with moisture from your breath. Sift a little lycopodium powder on the inside until it is coated with a thin layer, then fill it with water. Water now does not wet the sides of the container. Instead of rising slightly the water surface will be pulled down where it touches the glass, like mercury. Pour out the liquid and your container will be perfectly dry.

Oil From Old Wells

► OLD OIL WELLS, those exhausted by ordinary pumping methods, are now of primary interest to the oil industry, judging from discussions by the American Petroleum Institute.

Actually such wells are not exhausted; perhaps only one-third of the oil in the ground has been recovered. Science during the past two decades has found ways of getting another third or so out of the oil sands. The processes are called secondary recovery.

The historical background of using old wells in a secondary-recovery program was reviewed by W. A. Heath of Tulsa, Okla., who also discussed the present methods of reconditioning now widely used. Water flooding was legalized in Pennsylvania in 1921, although used for some time previously. Gas and air repressuring have been more general in application than water flooding, he said, and have been tried at some time or other in practically all of the older oil-producing areas.

In repressuring processes, a central old well, or one especially drilled for the purpose, is used to put water, gas or air, under high pressure, down into the oil-bearing sands to force the oil to the output wells. Natural gas is preferred wherever it is available because it not only provides the pressure but also mixes with the crude oil in the sands and promotes flow.

Natural gas is the most widely used injection medium, L. L. McWilliams, of the Phillips Petroleum Company, told the Institute, but manufactured fuel and inert gas, engine exhaust gas, and propane or butane hydrocarbons are used in rare cases.

He emphasized the need of knowing the impurities in any gas used. Hydrogen sulfide, carbon dioxide, oxygen and water vapors were mentioned as undesirable impurities. The difficulties may stretch from rust and corrosion of equipment in a well to plugging of the input-well bore by free sulfur.

**Roles of Individual Nutrients Studied
In White Blood Cell and Green Leaf**

Human Nutrition Research

by CHARLES GLEN KING

This address by the Scientific Director of The Nutrition Foundation was given at the Sixth Science Talent Institute in Washington, March 1947.

► OUT OF THE scattered findings of exploratory research and the very practical struggle to keep alive and happy, has come a relatively new, but well defined science of nutrition.

What are these men and women shooting at? What are their goals?

First, they want to know, what are the individual elements and compounds that must be supplied to the human body to maintain its normal functions.

Second, how can each nutrient, such as a vitamin or protein, be measured accurately—whether it be found in a white blood cell or in a green leaf.

Third, how can each be used to best advantage to protect animal and human health. (You will note that I have placed animal health first, not because it is more important, but because that is the normal order of progress.)

Fourth, we should know how each individual nutrient functions inside the body. This field is by far the most difficult. The reactions inside of us are exceedingly complex, but step by step the curtain of ignorance is yielding to the attack.

The human nutrient requirements are so poorly defined that many people

are shocked by an honest, simple statement of our very limited knowledge. For example:

(1) Of the nineteen mineral-type elements generally accepted as required by some forms of life, the evidence in regard to human nutrition scarcely goes beyond nine (calcium, phosphorus, magnesium, potassium, sodium, iron, copper, chlorine and iodine). Almost nothing has been established regarding the role of such elements as zinc, manganese, cobalt, molybdenum, boron and fluorine in the human body.

(2) Of the twenty-one or more amino acids that constitute the common proteins, apparently only eight are required for maintenance of body weight and nitrogen stores in the human adult, but very little is known concerning the role of the individual protein fragments beyond the bare question of nitrogen balance.

Not less than sixteen vitamins are required by various test animals, but evidence from human studies would scarcely include more than eight (A, B₁, B₂, C, D, K, niacin and folic acid).

Fats and carbohydrates are major items in all human diets, but very little has been established regarding a basic requirement for any member of either class. To a surprising degree they are still regarded as interchangeable in human diets. Dozens of sugars occur in nature, and about forty dif-

ferent fatty acids are recognized in edible fats. Of all the fatty acids, only one (linolenic acid) or two seem to be of crucial importance in animal feeding. Both fats and sugars contribute to an unquestioned caloric or energy need, but the ranges of their best use are still unknown.

The above comment refers primarily to mere qualitative requirement, and gives no emphasis to the fact that information is far less adequate concerning quantitative requirements. These should be known for each nutrient under the simplest conditions first, and then studies should be extended to include the variations in requirement that are associated with different circumstances such as age, environment and illness.

How, then, has man survived thus far? How serious are the flaws in current food practices?

A key to answering such questions lies in the fact that nearly all living cells have much in common. For example, most forms of plant life, if supplied with a selected group of minerals and water, prepare within their own cells the material that constitutes their growth. They build their own elaborate supply of proteins, fats, carbohydrates and vitamins chiefly from water, sunshine and carbon dioxide (from the air). Hence, with rare exceptions, green leaves and seeds are good foods for nearly all animals, including man.

In the modernization of our food supply, it is vitally important to know what must be in foods to meet the demands of health as well as convenience, cost and immediate pleasure.

Beyond the problem of education

to get the public to select and consume foods in accordance with actual need, the two chief causes of nutritional deficiencies are (a) mechanical losses during refining and (b) chemical destruction during processing, storage, distribution and cooking. These latter hazards are being avoided to an increasing degree under the leadership of scientists within the industry and they are being offset further by an increased use of foods of high nutritive quality, combined with high acceptability, such as citrus fruits, milk, meats and green leafy foods.

Perhaps the best appraisal of current and future research in human nutrition that I can give you would be in terms of specific examples selected from recent work.

In one of the New York laboratories, you will find a group of chemists and physicians working with Dr. O. A. Bessey, in the development of micro methods of analysis. They can start with two or three drops of blood from a finger tip and make accurate analyses of the following eight compounds, as a guide to what the person has been eating:

Vitamin A, carotene (a yellow leaf pigment); vitamin C, iron, hemoglobin (the red blood pigment); vitamin B₂, serum protein, and an enzyme called phosphatase that regulates calcium and phosphorus functioning in the body.

Their teams, with one physician, a chemist and a technician, can readily collect samples from 60 school children in an hour; and by the end of a second day, have the analyses completed. You can readily see that such methods are vastly superior to the old-fashioned method of looking at a per-

son and attempting to guess what he has been eating.

When visiting Professor Beadle's laboratory in Pasadena in December, I was really thrilled at seeing a group of young men and women studying new strains of bread mold. By use of X-rays, they were inducing genetic changes in the mold, so that succeeding generations of the tiny plants could not synthesize compounds that they could formerly make as needed. When the missing compound was supplied, growth again returned to normal. Hence they could use the new "tailor-made" plants to measure accurately all sorts of things that animals have to be supplied with in foods, such as vitamins and protein materials.

Other strains of the new plants could be shown to require a particular fragment of a protein or vitamin that is formed normally in human liver cells. Hence they could use the plant growth technique to measure specific compounds that are formed step by step in the human body. Some of the compounds thus studied are related to cancer, to fatty livers, to ice cream, to sulfa drugs.

Early in February I visited a group in Florida where they were searching for the cause of anemia as found commonly among school children. So far they have been baffled in their search. Meanwhile, some chemists who were studying animal nutrition were excited about their work on trace metals. Most chemists would associate the element molybdenum with alloy steel and automobile axles; but here they had found so much molybdenum in lush green grass growing in local areas, that cattle were being poisoned

by it. More surprising still was their discovery that feeding copper salts to the animals could quickly cure them of molybdenum poisoning. Copper, up to that time, had been regarded chiefly as an element that is necessary for the normal use of iron in building red blood cells. Now where are they? (Very busy, you may be sure!)

Meanwhile, medical nutrition groups at Vanderbilt University, the University of Cincinnati, Tulane University and Washington University have discovered that many of the cases of anemia in their clinics are caused by a new type of vitamin deficiency, discovered only last year. The vitamin is called folic acid because of its high content in green leaves.

You may say, "what difference does it make whether people eat the right foods?" One can only make rough estimates by way of answering, of course, but let us look at a few records. In a twelve year study at Harvard University, they found that physical defects and poor health were much more common in infants when their mothers' plane of nutrition had been low. The health records of the mothers showed the same type of correlation. The percentage of infants with especially perfect health scores within the first two weeks was four times higher when the mothers' diets had been good; and the infants with a poor health score were twenty times as frequent in the poorly nourished group. If applied to the nation as a whole, the corresponding improvement in health rating of infants would reach about one million per year.

Similar reports have come from competent medical centers in Baltimore and Toronto.

A group doing very careful work at the University of Minnesota reported last year that a single vitamin deficiency was causing heart failure and death in cattle. A group of chemists at Alabama Institute of Technology reported about a year ago that, for the first time, a nutritional deficiency had been found that could cause a high incidence of cancer, or tumor development, in white rats. Both studies were carefully conducted (and reported clearly) in working with cattle and albino rats, respectively, but there is no evidence, at present, to indicate whether the findings have any direct bearing on human problems.

For a more typical picture, let us look at the story of pellagra during the last ten years. The disease had been pretty well associated with poor food intake, and especially with eating too much corn. Chemists and physicians were elated when Dr. Elvehjem at the University of Wisconsin isolated from liver extract the vitamin that would cure the analogous disease, black tongue in dogs. Alert medical groups promptly extended the study to include human cases of pellagra. All went well for a time, but soon they found that foods such as milk could cure pellagra and black tongue, although they contained relatively small amounts of the vitamin. Dr. Elvehjem then spotted the new cura-

tive compound of one of the well known amino acids that are found in proteins. Again all seemed well for a time, but a few people were not satisfied about the relation of corn to pellagra. So they made extracts from corn to find whether there might be a third material that was interfering with the normal use of either the vitamin or the protein fragment. Such a factor, which might be called an "anti-vitamin," was found; so now they are trying to fit the puzzle together and find the underlying chemical changes that make the three compounds work together.

I scarcely need suggest that the science of nutrition is bringing together men and women with many different types of training. Largely, they come into the field as chemists, biologists, physiologists and physicians, but not uncommonly they make their contribution as physicists, dietitians, home economists, mathematicians, or even chemical engineers. They have a common goal in working toward a better understanding of what must be supplied to the body to protect it, in a chemical sense, and further, to find what happens to food inside the body. Agriculture, food manufacturing and many branches of medicine will benefit from their curiosity and their disciplined energy.

Better Than DDT

► A NEW insect-killing chemical, claimed to be even more effective than DDT against certain pests, is being put on the market by the Hercules

Powder Company. It is chlorinated camphene, and will be sold under the trade name Toxaphene.

**Synthetic Resins Solve Gas Fading
Mystery of Cellulose Acetate Fibers**

Another Dye Problem

Reprinted from "For Instance," American Cyanamid Company

► WHEN A NEW textile is invented, it creates new problems for the dye maker. Cellulose acetate is one whose development after World War I brought to the dye maker problems that had never been experienced with the previous man-made silk-like fibers such as viscose and cuprammonium rayons. Dyes which were applicable to these artificial silks and to the natural cellulosic fibers would not dye cellulose acetate; new ones had to be invented.

The new dyes which were thereupon developed were of satisfactory commercial fastness in most respects. It was soon found, however, that for no apparent reason cellulose acetate, dyed with some of them, changed shade. The mystery deepened when it was found that the fading sometimes occurred in dark storage. Fading was prevented if the garments or goods were sealed but developed locally around pinholes and cracks in the wrappings or enclosures. Examination of cross sections of the faded cellulose acetate under high magnification disclosed that the fading was not superficial but had taken place inside the fiber as well. The phenomenon was identified as a chemical change resulting from a reaction of air, dye and cellulose acetate, peculiar to the latter; it was described variously in the trade as "storage fading", "combustion fume

fading", "gas fading" and "atmospheric fading."

The detective work to single out the cause pursued the familiar course of methodically eliminating the possible culprit chemicals until it was found, in 1937, that air containing as little as 1 part per 100,000 of oxides of nitrogen caused fading of some dyed cellulose acetates.

Oxides of nitrogen are produced by combustion in air and are carried in smoke of factories and burnt gases of furnaces, stoves, gas heaters, etc. They are also formed by electrical discharges such as lightning and sparking motors. Air being approximately 80% nitrogen and 20% oxygen, it is not surprising that small quantities of oxides of nitrogen are formed when combustion in it takes place. In poorly ventilated rooms or buildings these oxides may reach sufficient concentration to be damaging, and cellulose acetate, dyed with the sensitive dyes, will inevitably fade when exposed to such fumes.

To study gas fading the chemists adopted a certain sensitive blue, dyed on cellulose acetate, as a standard for comparison. A test was devised subjecting variously-dyed cellulose acetate to controlled fading. This resulted in fixing the cause of gas fading as due to the chemical nature of certain acetate dyes and their reactivity in

cellulose acetate with the oxides of nitrogen.

Some improvements resulted from new dyes and modification of the older ones to arrest or divert these reactions but at the expense of brightness, light fastness or working qualities in application. Many finishing agents were found which arrested or almost prevented gas fading, but most were unsuitable for various reasons, solubility of some was poor, others changed the dyed shade too much, some were volatile and others marked off. None were sufficiently strongly held by the acetate to resist removal by rinsing, washing, perspiration or dry cleaning.

Investigation of the synthetic resins now coming into use for imparting crease resistance and shrinkage control led to the discovery that an alkylated methylol melamine provided a

clear water-soluble medium, which, when applied on cellulose acetate and cured, acted as an inhibitor against gas fading. As other water soluble inhibitors were not fixed on the acetate by super-imposing the resins nor by combining them prior to curing, it was established that the resin's ability to inhibit gas fading is an inherent property of the resin itself.

Thus the whole color range of available cellulose acetate dyes becomes available on suitable cloths. Resin finishing reduces the hazard of gas fading to the point where cloths previously requiring cautious handling can now be sold with the knowledge that the gas fading protection is not transitory but can withstand dry cleaning and wet processings such as washing and rinsing and not be unduly affected by perspiration.

New Porcelains for High Temperatures

► GLASS-FREE porcelains, of particular value in airplane sparkplugs and radar transformers, have been developed by the National Bureau of Standards. Withstanding heat up to 2,000 degrees Fahrenheit, they will have many applications in high-temperature electrical installations.

In making these new porcelains such materials as alumina, beryllia, zirconia and thoria are used. Also added are minor quantities of other metallic oxides, but they contain no silica.

The development of glass-free ceramic bodies has been a project of the Bureau since 1940, but it was pushed forward during the war to meet spe-

cial needs. Modern applications demand a porcelain of high mechanical strength, particularly at elevated temperatures, and good resistance to thermal shock, properties not found in ordinary porcelain.

Conventional porcelains contain feldspar in the mixture which reacts as a flux with the clay and silica to form a certain amount of a liquid glass that fills the tiny spaces between the crystals. This glass softens and deforms under stress at temperatures much lower than those at which the crystalline parts liquefy. The strength of the porcelain is largely dependent upon the matrix of glass. Therefore a glass-free porcelain was desired.

Dyes Are Classified By Composition and Use

For a Brighter World

The following section, on description and uses of dyes, is taken from the U. S. Tariff Commission's Report on DYES, prepared in response to requests from the Committee on Finance of the United States Senate and the Committee on Ways and Means of the House of Representatives, as No. 19 in the War Changes in Industry Series.

Raw materials

➤ ALMOST ALL synthetic dyes are made from derivatives of coal tar and light oil. These basic materials are obtained principally from coal in the process of converting coal to coke, usually in the byproduct coke ovens that produce coke for the steel industry. The so-called crudes—benzene, toluene,¹ xylene, naphthalene, carbazol, pyridine, anthracene, and the cresols—are derived from coal tar and light oils by simple distillation and further purification. These crudes, in turn, are used in the manufacture of intermediates, the chemicals which appear in the synthetic process between the primary raw materials and the finished coal tar products. Some purified crudes and intermediates are used as finished products. For example, naphthalene and paradichlorobenzene are used as moth repellents; phenol and the cresols as disinfectants; and benzene, toluene, and xylene as solvents, motor fuel additives, and paint removers.

¹During World War II large quantities of toluene were derived from petroleum.

Classes of dyes

The United States dye industry turns out more than 1,500 individual dyes. This wide range is made necessary by the many types of materials on which dyes are used and the different conditions of service for which they are required. There are, for example, more than 250 different blues on the market. Most dyes are in more or less continuous production; a few are produced only as changed styles or new products demand them.

Dyes are broadly grouped by chemical structure and by class of application. Below are the groupings used by the United States Tariff Commission and by the trade in general, alphabetically arranged. These groups are flexible but comprehensive. All dyes fall in one of them, and some may be placed in two or more groups.

Acetate silk dyes.—The majority of acetate silk dyes are insoluble azo compounds; the rest are chiefly insoluble anthraquinone derivatives. They are applied in a highly dispersed form with the aid of wetting agents, such as the newly developed synthetic detergents, specially adapted soaps, or sulfonated oils. The increasing importance of this class of dyes closely parallels the most recent expansion of the domestic acetate-rayon industry.

Dyes in this group are specially adapted for the purpose of dyeing cellulose acetate rayons. This rayon has practically no affinity either for direct

cotton dyes or acid wool dyes; consequently, it became necessary to develop a new type of dye before acetate could attain commercial importance as a textile. When acetate silk dyes are applied to mixed fabrics containing cotton, or rayon other than acetate, only the acetate silk fibers are dyed. Unique pattern effects are thus made possible.

Acid dyes.—Most of the acid dyes are the sodium salts of aromatic sulfonic acid derivatives and are applied in a neutral or an acid bath. They are derived chiefly from azo compounds of benzene, toluene, and naphthalene and can readily be mixed with each other to produce compound shades. Silk and wool are protein fibers containing basic and acidic groups in their structure so that they have a special affinity for both acid and basic dyes, depending upon dyeing conditions. Acid dyes represent the most important type for dyeing wool and are also used extensively on silk. They have proved most satisfactory when used on goods not requiring repeated washings (such as carpets, suiting, dress goods, and hat materials). Acid dyes are little used on cotton and linen.

Azoic dyes.—Most of the azoic dyes are the higher priced specialties now generally marketed as the rapidogens, diagens, rapid fast colors and their components, such as the fast color salts and naphthol AS derivatives. They are often called developed dyes since the insoluble color is actually produced within the fiber from soluble constituents. Another name—ice colors—is sometimes used for this group because the coupling of the components must be carried out in cooled water in order to control the

diazo reaction. Some dyes in this group are sold in a prepared form (stabilized azoics) so that a simple preparation can be directly applied to the material in an acid bath. They are used mainly for high-quality dyeing and printing of cotton goods, particularly if brilliant shades which are fast to washing are desired (e.g., brilliant reds not obtainable in vat colors).

Basic dyes.—Basic dyes are salts of organic bases² and are chiefly used on cotton and silk. Cotton (or any vegetable fiber) is frequently dyed with the aid of a tannin mordant³ or synthetic substitute therefor; silk (or animal fiber) is dyed directly without the use of a mordant. The basic dyes surpass all others in depth, purity of tone, and brilliance. They lack fastness to light and washing. Their importance as a group for application to textiles is diminishing, but they are extensively used on paper because of their great tinctorial power. For dyeing cotton they have been largely superseded by vat and azoic dyes, which have equal brilliance and are extremely fast to light and washing.

Direct or substantive dyes.—Azo compounds that can be applied to cotton without the use of a mordant, and, under certain conditions, to silk and wool are called direct or substantive dyes. Although the principal application of direct dyes is on cotton, they are especially useful for dyeing mixed goods (i.e., fabrics containing both cotton and wool or both cotton and silk). Direct dyes are also used on silk goods, linen, and paper. They are applied to

² An organic base contains nitrogen or a nitrogen (amino) group.

³ Cotton previously dyed with direct or sulfur colors may be dyed directly with basic colors.

various wool manufactures, especially to wool for knitting yarns, worsted and shoddy yarns, and loose wool.

Dyes of this group, as originally developed, had a tendency to run, were sensitive to acids, and faded on exposure to sunlight. These undesirable characteristics have now been largely eliminated through after-treatment of the dyed materials, or through development of the original dye in the fiber with metallic salts, formaldehyde, or azo intermediates capable of coupling with the original dye. Direct dyes are produced in greater volume than any other class because of the large quantity of colored cotton worn in the United States.

Lake and spirit-soluble dyes.—

Among the smaller groups are the lake and spirit-soluble dyes. Lake dyes are largely azo compounds which can be combined with certain metallic salts (barium, chromium, and aluminum) to form insoluble organic colors known as color lakes. These pigments are used chiefly for coloring paints and printing inks. Spirit-soluble dyes are closely related to textile dyes but do not dissolve in water since they lack the chemical radicals (sulfonic acid, chloride, and ammonium) that impart water solubility. They dissolve in oils, fats and various organic solvents. Some of the spirit-soluble dyes might be considered as intermediates because they can be converted by simple chemical treatment into water-soluble dyes suitable for textile application. Spirit-soluble dyes are used for coloring gasolines; clear varnishes and lacquers; oils, fats, and waxes; and similar products.

Mordant and chrome dyes.—Mor-

dant and chrome dyes usually contain hydroxyl and carboxyl groups, which can form complex lakes when applied in conjunction with metallic mordants, such as salts of chromium, aluminum, iron, and tin. They are used chiefly on wool. The lakes are formed within the fiber and their color-fastness is excellent. The labor cost of dyeing with mordant and chrome dyes is greater than with most of the other groups.

Alizarin, originally a natural dye but now made synthetically from anthraquinone, is typical. Different colors can be obtained by using alizarin with different salts: red with aluminum or tin salts, red-brown with calcium salts, brown with chromium salts, and blue-black with iron salts. Over 200 derivatives of alizarin are now on the market.

Sulfur dyes.—Sulfur dyes are prepared by heating certain coal-tar intermediates, containing nitro or amino groups or both, with sulfur and sodium sulfide. When sulfur dyes are applied to textiles, they must first be dissolved with sodium sulfide in order to form the soluble leuco compound, which is then applied to the fiber in an alkaline solution containing common salt. The insoluble sulfur color is subsequently reformed by oxidation in the air or in an oxidizing solution containing hydrogen peroxide.

These inexpensive dyes produce heavy shades of blue, green, brown, and black which are fast to light, washing, acids, and alkalis. They are not fast to the strong bleaching agents (e.g. chlorine) used in modern laundries, but sometimes they are given aftertreatment with metallic salts (e.g. chromium and copper) to improve

their fastness to light and washing. Sulfur dyes are used on cotton, especially uniform cloths, hosiery, gingham yarns, and cotton warps that are to be woven with wool and later dyed with acid dyes.

Vat dyes.—The most stable agents for coloring textiles are the indigoid and anthraquinone vat dyes. They are insoluble in water⁴ and must be applied in a strongly alkaline sodium hydrosulfite solution or "vat." When the dyed material is exposed to the air or treated with oxidizing agents, the insoluble form of the dye is regenerated and becomes a permanent part of the fiber. Vat dyes (including indigoid and anthraquinone vats) rank first among all of the groups listed in order of value, constituting, in ordinary times, about one-fourth of the total value of dyes produced.

Indigo, a typical member of this group of dyes, is widely used on denims and other fabrics for work clothes because of its very low cost and excellent fastness to washing. The indigoid vat dyes are exceeded in fastness to color-destroying agents only by the more expensive anthraquinonoid types. The superior fastness of the latter, and the variety and beauty of shades which the anthraquinone vat dyes yield, are largely responsible for the steady increase in their use despite the high cost.

Until very recently, vat dyes were used almost exclusively on cotton goods, but new processes have recently been patented which allow their application to rayons, wool gabardines,

⁴ Some indigoid and anthraquinone vat dyes, such as the indigosols and soledons are sold to the user in a reduced water-soluble form.

wool challis, and military trouser materials.

Food, drug, and cosmetic dyes.—Food, drug, and cosmetic colors are specially selected by the Food and Drug Administration, Federal Security Agency. The certification and use of these dyes are governed by regulations promulgated under authority of the Food, Drug, and Cosmetic Act of 1938. Coal-tar colors may be certified for use in foods, drugs, and cosmetics (F.D. and C. colors); or for drugs and cosmetics (D. and C. colors); or for externally applied drugs and cosmetics (Ext. D. and C. colors), provided that laboratory examination shows such colors to be harmless and suitable for the intended use. About one hundred certified dyes (as well as lakes and mixtures prepared therefrom) are now in use for coloring products such as butter and margarin, beverages, bakery goods, candies, gelatin desserts and sherbets, ice cream, prepared medicinals, and cosmetics.

Uses of dyes

The uses of dyes are numerous. Before the war the textile industry, embracing the manufacture of cotton, wool, silk, rayon, and other fabrics, took about 80 percent of the quantity of dyes consumed in this country. The paper industry ordinarily uses about 7 percent, and the leather industry about 2 percent. Among other commodities in which dyes are normally used are the following:

- Biological stains and chemical indicators
- Colored photographs and direct-color photography
- Crayons, carbon papers, and typewriter ribbons

Drugs and medicinals
Feathers and furs
Gasoline
Matches
Plastics and rubber
Prepared foods and fruits
Printing and writing inks
Protective coatings, wood stains,
and water colors
Soaps, cosmetics, and hair colors
Stove and shoe polishes
Tobacco

In addition to these peacetime uses, dyes were adapted to numerous military requirements during World War II. Special types of fluorescent dyes, such as uranine, were used in marking the positions of airplane and shipwrecked crews forced into the water. Dyes were used in coloring signaling

smokes to identify tanks, vehicles, and other combat equipment and to aid in observing the accuracy of long-range artillery. Other wartime applications of dyes were in camouflage ointments for troops in jungle combat and as indicators to detect the presence of poison gases. Marine crews used a black dye as protection against sharks. Apart from dyes themselves, new synthetic medicinals and insecticides, synthetic rubbers, powerful motor fuels, and highly destructive explosives were produced in rapidly increasing quantities, employing technical processes closely related to those used in producing dyes. Research and technical developments associated with the wartime manufacture of dyes and related articles are certain to benefit national welfare in peacetime.

Fission Products Found in Air

► NEW AND RARE radioactive gas was generated by the second atomic bomb at Bikini and was detected in the atmosphere over Oklahoma three days later.

This is the conclusion presented in a report to the Physical Review, journal of the American Physical Society, by a group of five Tulsa scientists, R. E. Fearson, A. Wendell Engle, Jean Thayer, Gilbert Swift and Irving Johnson.

Radioactive concentrates were prepared from the atmosphere and radioactive decay constants were determined. The scientists concluded that the deposit obtained July 28 consisted of element 86 with a half life of 82

minutes. Element 86 is radon, a radioactive gas which is known as the first disintegration product of radium. The kind of radon found by the Tulsa scientists would be a different variety or isotope from the one obtained from radium and may be in an unreported radioactive series.

There has been apprehension that atomic bomb fission products would float around the world, polluting the air. Scientists in many places set up experiments to detect atmospheric effects, but negative results were obtained in most places. A marked increase in gamma rays was reported from Houston, Texas, on July 4 and linked with the first explosion at Bikini July 1.

Metals Tested in Dugout

► SPINNING, RED-HOT metal discs in a special dugout at the Westinghouse Research Laboratories in Pittsburgh are going to help develop parts for future jet engines.

Heated to temperatures above 1,400 degrees Fahrenheit, the discs will spin at speeds of 1,200 miles per hour until they fly apart. The discs, made of specially developed alloys, will reveal the maximum strength of the materials to help engineers plan new alloys for engines.

The "metal torture" tests will be made in a dugout sunk 10 feet below floor level and lined with sandbags.

Metals to be tested are used in the rotors of present gas-turbine engines where they stand up under terrific stress and temperature. In the tests, actual operating conditions will be exceeded to find out how much heat and stress is needed to break up the metal.

From the tests in the dugout, Westinghouse engineers hope to devise principles from which they can predict the behavior of metals at any speed or temperature.

The discs, which will whirl at



► STRENGTH of jet engine alloys being tested by Westinghouse scientists who use a high-speed motor to whirl the metal disks.

35,000 revolutions per second, are one foot in diameter and one inch thick.

On the Back Cover

► SPHERULITES of cholesteryl acetate forming within the unstable high-temperature liquid modification of the same substance were photographed with crossed nichol prisms at a magnification of 100 to give the interesting pattern shown on the back of this month's CHEMISTRY.

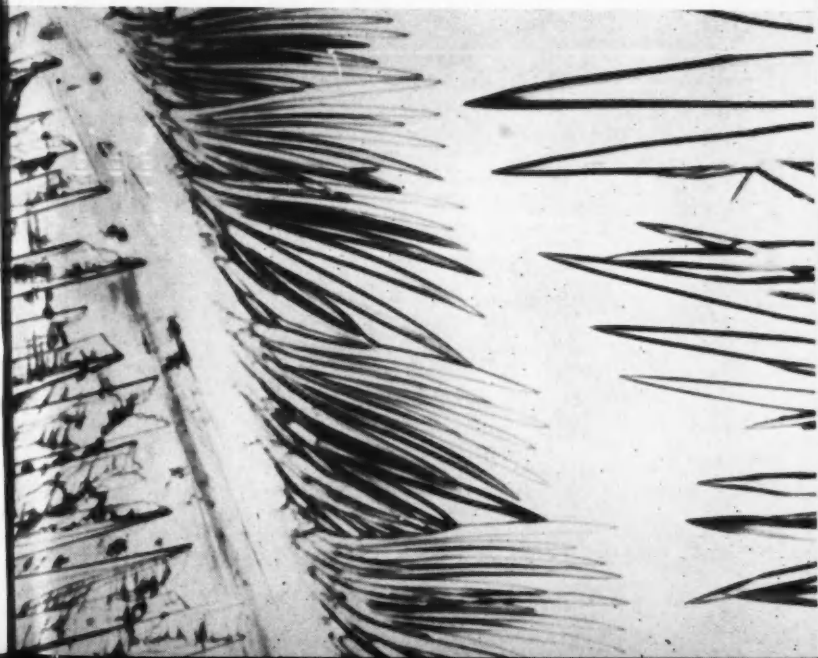
Crystalline Polymorphs And Liquid Eutectics

Crystals Identify Compounds

➤ MORE INFORMATION about organic compounds can be gotten by letting them crystallize in thin films on microscope slides than by some of the more elaborate methods of analysis. The optical properties of the crystalline film are characteristic of the compound present. Polymorphism is apparent as a secondary crystal growth occurring through the first solid phase. Impurities would appear as liquid eutectic lying between the

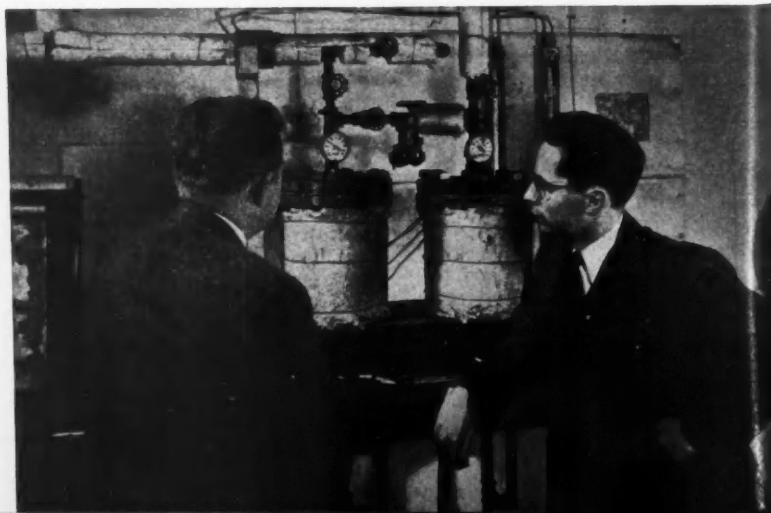
crystals and the cover slip. The more impure the compound the more liquid eutectic would be visible. The accompanying photograph, which shows two different compounds and their intermediate addition product, and the picture on the back cover, of crystals forming in a liquid matrix, were taken by the Armour Research Foundation, Illinois Institute of Technology.

➤ A MIXED FUSION preparation of tri-nitro-toluene and mono-nitro-naphthalene shows feathery crystals of their addition compound spreading out in the space between them.





► "COAL ATOMIZER" and attrition chamber are being examined in the lower picture, by John I. Yellott, director of research, and W. N. McDaniel of the Locomotive Development Committee of Bituminous Coal Research Laboratory at Johns Hopkins University. Above, Mr. Yellott and his assistant director witness test to determine the possibility of spontaneous ignition of coal stored under pressure.



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**Low Pressures Distill Substances
Never Vaporized Before**

High-Vacuum Molecular Still

► LIQUIDS AND SOLIDS never vaporized before yield to a high-vacuum evaporating process which is now being used to determine just what constitutes petroleum.

The equipment used is called a molecular still. It is a five-foot glass tower, in which the vacuum is obtained, with a complex system of electric leads, radio tubes, mercury boiler system, vacuum measuring apparatus, and a series of vacuum pumps. The vacuum obtained has less than one billionth of atmospheric pressure, it is claimed.

Within this vacuum, solids as well as liquids can be evaporated into their various molecular parts. Oils, greases and waxes are divided into several hundred components with a degree of separation never before obtained. These components are made for various tests relative to physical and other properties. Results are expected to be used in refineries in the production of improved petroleum products.

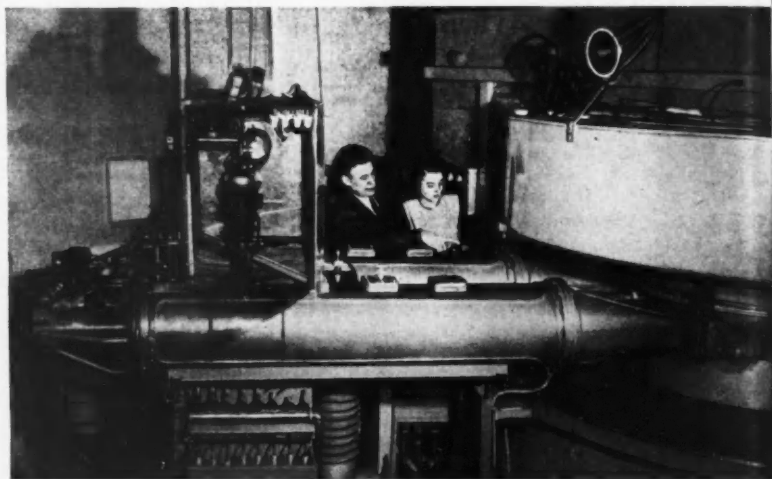
The basic action of molecular distillation is to cause separation according to the sizes of the molecules. Chemicals in disintegrating petroleum products alter their nature. This evaporation process does not. Ordinary distillation takes place at the boiling point of the liquid being treated. Boiling points are lowered as the atmospheric pressure is decreased. With the extremely low pressure in this high-vacuum still, even solids evaporate,



► DISTILLING *solids and liquids.*

but evaporation of most solids is too slow for ordinary research uses.

This evaporation takes place between a hot plate and a cold condensing plate in the vacuum. Molecules of the treated material on the hot plate travel to the cold plate. It takes many months even to dissect a petroleum product into its hundreds of parts. This molecular still is being used in the Pittsburgh research laboratories of the Gulf Oil Corporation.



► JUST PLACED in operation at the University of Pittsburgh, this atom-smasher provides 200,000-volts "pushes" for the ions circulating in the vacuum chamber, seen between circular tanks at right. Tanks contain 18 miles of copper coiled about magnet poles and cooled by 467 gallons of cyclotron oils developed by Gulf Research.

World Chemical Meeting in London

► THE FIRST international gathering of chemists since the war will be held this summer in London, July 16 to 24. This congress will follow immediately the centenary meeting and celebrations of Great Britain's Chemical Society.

Like the actual 100th anniversary of the formation of the Chemical Society, the Eleventh International Congress of Pure and Applied Chemistry should have been held in 1941 but it was postponed because of the war. A large delegation of American chemists to the July congress will be led by Dr. Marston T. Bogert of Co-

lumbia University, president of the International Union of Chemistry.

The congress, under the presidency of Viscount Leverhulme, will have sections devoted to inorganic and geochemistry, physical chemistry, organic chemistry, biochemistry, and sections on chemistry related to agricultural and applied botany, applied zoology and veterinary science, food and nutrition, medicine and therapeutics, fuel, power and transport, natural and artificial textiles, plastics, glass and ceramics, metals, chemical engineering.

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